



## 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



|                                                  |                                                                                   |                                          |
|--------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------|
| <b>FCC ID:</b> BCGA2825<br><b>IC:</b> 579C-A2825 | <b>MAXIMUM PERMISSIBLE EXPOSURE<br/>REPORT</b>                                    | <b>Approved by:</b><br>Technical Manager |
| <b>Test Report S/N:</b><br>1C2206300045-09.BCG   | <b>Test Dates:</b><br>6/30/2022 - 10/19/2022<br><b>EUT Type:</b><br>Smart Speaker | Page 1 of 12                             |

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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 <sup>2</sup> ) | 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)**

|                                         |                                                                                                                                |                            |                                   |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------|
| FCC ID: BCGA2825<br>IC: 579C-A2825      |  <b>MAXIMUM PERMISSIBLE EXPOSURE REPORT</b> |                            | Approved by:<br>Technical Manager |
| Test Report S/N:<br>1C2206300045-09.BCG | Test Dates:<br>6/30/2022 - 10/19/2022                                                                                          | EUT Type:<br>Smart Speaker | Page 3 of 12                      |

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| Frequency Range (MHz)                                                                                          | Electric Field Strength (V/m) | Magnetic Field Strength (A/m)            | Power Density (W/m <sup>2</sup> ) | Reference Period (Minutes) |
|----------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------------------------|-----------------------------------|----------------------------|
| (A) RF Field Strength Limits For Controlled Use Devices (Controlled Environment) (f = frequency)               |                               |                                          |                                   |                            |
| 20-48                                                                                                          | 129.8/ f <sup>0.25</sup>      | 0.3444/ f <sup>0.25</sup>                | 44.72/ f <sup>0.5</sup>           | 6                          |
| 48-100                                                                                                         | 49.33                         | 0.1309                                   | 6.455                             | 6                          |
| 100-6000                                                                                                       | 15.60 f <sup>0.25</sup>       | 0.04138 f <sup>0.25</sup>                | 0.6455 f <sup>0.5</sup>           | 6                          |
| 600-15000                                                                                                      | 137                           | 0.364                                    | 50                                | 6                          |
| 15000-150000                                                                                                   | 137                           | 0.364                                    | 50                                | 616000/ f <sup>1.2</sup>   |
| 150000-300000                                                                                                  | 0.354 f <sup>0.5</sup>        | 9.40 x 10 <sup>-4</sup> f <sup>0.5</sup> | 3.33 x 10 <sup>-4</sup> f         | 616000/ f <sup>1.2</sup>   |
| (B) RF Field Strength Limits For Devices Used by the General Public (Uncontrolled Environment) (f = frequency) |                               |                                          |                                   |                            |
| 20-48                                                                                                          | 58.07/ f <sup>0.25</sup>      | 0.1540/ f <sup>0.25</sup>                | 8.944/ f <sup>0.5</sup>           | 6                          |
| 48-300                                                                                                         | 22.06                         | 0.05852                                  | 1.291                             | 6                          |
| 300-6000                                                                                                       | 3.142 f <sup>0.3417</sup>     | 0.008335 f <sup>0.3417</sup>             | 0.02619 f <sup>0.6834</sup>       | 6                          |
| 6000-15000                                                                                                     | 61.4                          | 0.163                                    | 10                                | 6                          |
| 15000-150000                                                                                                   | 61.4                          | 0.163                                    | 10                                | 616000/ f <sup>1.2</sup>   |
| 150000-300000                                                                                                  | 0.158 f <sup>0.5</sup>        | 4.21 x 10 <sup>-4</sup> f <sup>0.5</sup> | 6.67 x 10 <sup>-5</sup> f         | 616000/ f <sup>1.2</sup>   |

**Table 1-2. ISD 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.:** GY9Y GK3GVM, 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.

|                                         |                                                                                     |                                        |                                   |
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### 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.

|                                         |                                                                                     |                                        |                                   |
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## 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<sup>2</sup>)

$P_{out}$  = output power to antenna (mW)

G = gain of antenna in linear scale

$\pi$  = 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    |                  |
|------------------------------------|---------|--------------------|---------|------------------|
| <b>Frequency</b>                   | 2417    | MHz                | 2417    | MHz              |
| <b>Limit</b>                       | 1.000   | mW/cm <sup>2</sup> | 5.374   | W/m <sup>2</sup> |
| <b>Limit Distance (cm), R =</b>    | 20.00   | cm                 | 0.20    | m                |
| <b>Power (dBm), P =</b>            | 24.33   | dBm                | 24.33   | dBm              |
| <b>Power (mW), P =</b>             | 271.019 | mW                 | 0.271   | W                |
| <b>Tx Ant Gain (dBi), G =</b>      | 3.0     | dBi                | 3.0     | dBi              |
|                                    |         |                    |         |                  |
| <b>Power Density (S) at 20cm =</b> | 0.10758 | mW/cm <sup>2</sup> | 1.07579 | W/m <sup>2</sup> |
| <b>Minimum Distance =</b>          | 6.55986 | cm                 | 0.08949 | m                |

**Table 1-3. Calculated MPE for WLAN**

|                                                  |                                                                                                                                    |                                   |                                          |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------|
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|                             | FCC     |                    | ISED    |                  |
|-----------------------------|---------|--------------------|---------|------------------|
| Frequency                   | 2441    | MHz                | 2441    | MHz              |
| Limit                       | 1.000   | mW/cm <sup>2</sup> | 5.410   | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 0.19441 | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 5.466   | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 0.10180 | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 5.466   | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 0.19894 | W/m <sup>2</sup> |
| Minimum Distance =          | 2.82094 | cm                 | 0.03816 | m                |

Table 1-6. Calculated MPE for Bluetooth LE

|                                         |                                                                                                                            |                            |                                   |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------|
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|                             | FCC     |                    | ISED    |                  |
|-----------------------------|---------|--------------------|---------|------------------|
| Frequency                   | 5580    | MHz                | 5580    | MHz              |
| Limit                       | 1.000   | mW/cm <sup>2</sup> | 9.519   | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 0.23863 | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 10.000  | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 0.00135 | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 10.000  | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 0.00163 | W/m <sup>2</sup> |
| Minimum Distance =          | 0.25550 | cm                 | 0.00256 | m                |

Table 1-9. Calculated MPE for UWB Antenna 1

|                                         |                                                                                                                            |                            |                                   |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------|
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|                             | FCC     |                    | ISED    |                  |
|-----------------------------|---------|--------------------|---------|------------------|
| Frequency                   | 2440.0  | MHz                | 2440.0  | MHz              |
| Limit                       | 1.000   | mW/cm <sup>2</sup> | 5.409   | W/m <sup>2</sup> |
| 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 <sup>2</sup> | 0.12698 | W/m <sup>2</sup> |
| Minimum Distance =          | 2.25369 | cm                 | 0.03064 | m                |

**Table 1-10. Calculated MPE for 802.15.4**

|                                         |                                                                                                                                    |                            |                                   |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------|
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## 1.5 Summary of Results

|                              | Power Density<br>(mW/cm <sup>2</sup> ) | Limit<br>(mW/cm <sup>2</sup> ) | Percent MPE<br>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

|                                         |                                                                                     |                                        |                                   |
|-----------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------|-----------------------------------|
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|                              | Power Density<br>(W/m <sup>2</sup> ) | Limit<br>(W/m <sup>2</sup> ) | Percent MPE<br>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

|                                         |                                                                                     |                                        |                                   |
|-----------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------|-----------------------------------|
| FCC ID: BCGA2825<br>IC: 579C-A2825      |  | MAXIMUM PERMISSIBLE EXPOSURE<br>REPORT | Approved by:<br>Technical Manager |
| Test Report S/N:<br>1C2206300045-09.BCG | Test Dates:<br>6/30/2022 - 10/19/2022                                               | EUT Type:<br>Smart Speaker             | Page 11 of 12                     |

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## 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.

|                                                  |                                                                                     |                                                |                                          |
|--------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------|
| <b>FCC ID:</b> BCGA2825<br><b>IC:</b> 579C-A2825 |  | <b>MAXIMUM PERMISSIBLE EXPOSURE<br/>REPORT</b> | <b>Approved by:</b><br>Technical Manager |
| <b>Test Report S/N:</b><br>1C2206300045-09.BCG   |                                                                                     |                                                | Page 12 of 12                            |
| <b>Test Dates:</b><br>6/30/2022 - 10/19/2022     | <b>EUT Type:</b><br>Smart Speaker                                                   |                                                |                                          |

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