CERTIFICATION TEST REPORT

Report Number. : 13018918-E15V2

Applicant	:	APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
Model	:	A2296
FCC ID	:	BCG-E3501A
IC	:	579C-E3501A
EUT Description	:	SMARTPHONE
Test Standard(s)	:	FCC PART 1 SUBPART I AND PART 2 SUBPART J IC RSS-102 ISSUE 5

Date Of Issue:
MARCH 26, 2020

Prepared by:
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	3/26/2020	Initial Review	Mengistu Mekuria
V2	3/26/2020	Addressed TCB Questions	Mengistu Mekuria

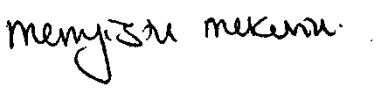
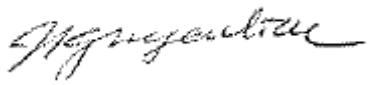
TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS

Applicant Name and Address	APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
Model	A2296
FCC ID	BCG-E3501A
IC	579C-E3501A
EUT Description	SMARTPHONE
Serial Number	FFMZW06XPM62,FFMZW038PM62
Applicable Standards	FCC PART 1 SUBPART I AND PART 2 SUBPART J IC RSS-102 ISSUE 5
Test Results	COMPLIES

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.

Approved & Released By:	Prepared By:
	
Mengistu Mekuria Lead Test Engineer UL Verification Services Inc.	Lieu Nguyen Laboratory Engineer UL Verification Services Inc.

2. TEST METHODOLOGY

All calculations were made in accordance with FCC OET Bulletin 65 Edition 97-01 and IC Safety Code 6.

3. REFERENCES

All transmit characteristics used in this evaluations were documented in the UL Verification Services Inc. document 13018918-S1V1 (SAR report) and Antenna Gain exhibit

Output power and Duty cycle is excerpted from the SAR report. Antenna gain data is excerpted from Antenna Gain exhibit.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

The above test sites and facilities are covered under FCC Test Firm Registration # 208313.
UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at NVLAP Lab Search.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEEE 802.11 a/b/g/n/ac/ax, Bluetooth, GPS and NFC. All models support at least one UICC based SIM. The second SIM, if present, is either UICC based p-SIM (physical SIM or e-SIM (electronic SIM). The device has a built-in inductive charging receiver. The rechargeable battery is also not user accessible.

The MPE analysis performed in this report evaluates a unique mobile use case where the handset is placed on a Apple proprietary wireless charger. The cellular, WiFi and Bluetooth transmitters can be active while being charged. The power levels used and reported in this analysis are specific for this use condition only. Simultaneous transmission for these transmitters are analyzed herein without the wireless charger. The simultaneous transmission use condition and permitted configuration together with the charger will be addressed in the applicable wireless charger certification application

5.2. WORST-CASE CONFIGURATION AND MODE

The worst-case is when the EUT is transmitting on the highest power allowed for each of the transmit bands, as specified in the SAR reports

The table below is used to determine the worst-case co-located simultaneous transmission for evaluation.

Simultaneous Transmission	Technology	WLAN 2.4	BT 2.4	WLAN 5G
Technology	Output Power (dBm)	21.5	20.0	21.0
GSM 850	32.75	*	*	*
GSM 1900	31.25	**	**	**
WCDMA Band II	24.25	**	**	**
WCDMA Band IV	24.50	**	**	**
WCDMA Band V	25.20	**	**	**
CDMA/EVDO BC0	25.20	**	**	**
CDMA/EVDO BC1	24.25	**	**	**
CDMA/EVDO BC10	25.20	**	**	**
LTE Band 2	24.25	**	**	**
LTE Band 4	24.50	**	**	**
LTE Band 5	25.20	**	**	**
LTE Band 7	25.20	**	**	**
LTE Band 12	25.20	**	**	**
LTE Band 13	25.20	**	**	**
LTE Band 14	25.20	**	**	**
LTE Band 17	25.20	**	**	**
LTE Band 25	24.25	**	**	**
LTE Band 26	25.20	**	**	**
LTE Band 30	23.50	**	**	**
LTE Band 41	28.00	**	**	**
LTE Band 48	25.00	**	**	**
LTE Band 66	24.50	**	**	**

Note: * Worst Case for the Co-located MPE Calculation based on the output powers.

The GSM 850 may have been used not only because it had the highest conducted power level, but it does provide the lowest margin of power density to the FCC limit.

6. MAXIMUM PERMISSIBLE RF EXPOSURE

6.1. 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

6.2. IC RULES

IC Safety Code 6 (2015), Section 2.2.2: To ensure compliance with the basic restrictions outlined in Section 2.1, at frequencies between 10 MHz and 300 GHz, the reference levels for electric- and magnetic-field strength and power density must be complied with.

TABLE 2: Reference Levels for Electric Field Strength, Magnetic Field Strength and Power Density in Uncontrolled Environments

Table 2: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Note: f is frequency in MHz.				
Frequency Range (MHz)	**Electric Field (V/m rms)**	**Magnetic Field (A/m rms)**	**Power Density (W/m²)**	**Reference Period (minutes)**
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	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

TABLE 3: Reference Levels for Electric Field Strength, Magnetic Field Strength and Power Density in Controlled Environments

Table 3: RF Field Strength Limits for Controlled Use Devices (Controlled Environment)				
Note: f is frequency in MHz.				
Frequency Range (MHz)	**Electric Field (V/m rms)**	**Magnetic Field (A/m rms)**	**Power Density (W/m²)**	**Reference Period (minutes)**
10-20	61.4	0.163	-10	6
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
6000-15000	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

6.3. 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 CO-LOCATED TRANSMITTERS (Identical limits for 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.

MIMO AND COLOCATED TRANSMITTERS (Different limits for Transmitter)

For multiple colocated transmitters operating simultaneously in frequency bands where different limits apply:

The Power Density at the specified separation distance is calculated for each transmitter chain or transmitter.

The fraction of the exposure limit is calculated for each chain or transmitter as
(Power Density of chain or transmitter) / (Limit applicable to that chain or transmitter).

The fractions are summed.

Compliance is established if the sum of the fractions is less than or equal to one.

6.4. IC EXEMPTION

INDUSTRY CANADA EXEMPTION

RSS-102 Clause 2.5.2 RF exposure evaluation is required if the separation distance between the user and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1.31 x 10-2 f0.6834 W (adjusted for tune-up tolerance), where f is in MHz;

7. 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.

(Single chain transmitters, no co-location, 20 cm MPE distance)

Stand-alone Transmitter Power Density							
Band	**Mode**	**Separation Distance (cm)**	**Output AVG Power (dBm)**	**Antenna Gain (dBi)**	**EIRP (mW)**	**FCC Power Density (mW/cm^2)**	**IC Power Density (W/m^2)**
850 MHz	GSM	20	32.75	-1.70	1273.5	0.253	2.53
1900 MHz	GSM	20	28.00	1.40	871.0	0.173	1.73
Band II	WCDMA	20	24.25	-2.00	167.9	0.033	0.33
Band IV	WCDMA	20	24.50	-4.10	109.6	0.022	0.22
Band V	WCDMA	20	25.20	-1.70	223.9	0.045	0.45
BC0	CDMA/EVDO	20	25.20	-1.70	223.9	0.045	0.45
BC1	CDMA/EVDO	20	24.25	-2.00	167.9	0.033	0.33
BC10	CDMA/EVDO	20	25.20	-2.40	190.5	0.038	0.38
Band 2	LTE	20	24.25	-2.00	167.9	0.033	0.33
Band 4	LTE	20	24.50	-4.10	109.6	0.022	0.22
Band 5	LTE	20	25.20	-1.80	218.8	0.044	0.44
Band 7	LTE	20	25.20	-2.60	182.0	0.036	0.36
Band 12	LTE	20	25.20	-4.70	112.2	0.022	0.22
Band 13	LTE	20	25.20	-3.30	154.9	0.031	0.31
Band 17	LTE	20	25.20	-4.70	112.2	0.022	0.22
Band 25	LTE	20	24.25	-2.00	167.9	0.033	0.33
Band 26	LTE	20	25.20	-2.70	177.8	0.035	0.35
Band 30	LTE	20	23.50	-0.40	204.2	0.041	0.41
Band 41	LTE	20	28.00	-2.60	346.7	0.069	0.69
Band 48	LTE	20	25.00	-2.80	167.6	0.033	0.33
Band 66	LTE	20	24.50	-3.40	128.8	0.026	0.26
2.4 GHz	BT	20	20.00	-0.40	91.2	0.018	0.18
2.4 GHz	WLAN	20	21.50	-0.40	128.8	0.026	0.26
5 GHz	WLAN	20	21.00	-0.10	123.0	0.024	0.24

Based on the Power density calculations, all values meet the IC limits specified in section 6.4 and are exempt from routine RF exposure evaluation.

(MIMO and/or Co-located transmitters all with same Power Density limit, 20 cm MPE distance)

Simultaneous Transmitter Power Density								
Band	**Mode**	**Antenna for MIMO**	**Separation Distance (cm)**	**Output AVG Power (dBm)**	**Antenna Gain (dBi)**	**EIRP (mW)**	**FCC Power Density (mW/cm^2)**	**IC Density (W/m^2)**
2.4 GHz	Bluetooth	LAT 3		20.00	-0.40	91.2		
2.4 GHz	Bluetooth	UAT 1		19.00	-2.20	47.9		
5 GHz	WLAN	LAT 3		21.00	-0.10	123.0		
5 GHz	WLAN	UAT 2		17.75	-2.60	32.7		
Combined			20			294.8	0.059	0.59

Simultaneous Transmitter Power Density								
Band	**Mode**	**Antenna for MIMO**	**Separation Distance (cm)**	**Output AVG Power (dBm)**	**Antenna Gain (dBi)**	**EIRP (mW)**	**FCC Power Density (mW/cm^2)**	**IC Density (W/m^2)**
2.4 GHz	WLAN	LAT 3		21.50	-0.40	128.8		
2.4 GHz	WLAN	UAT 1		19.00	-2.20	47.9		
Combined			20			176.7	0.035	0.35

Notes:

1) For MPE the new KDB 447498 requires the calculations to use the maximum rated power; that power should be declared by the manufacturer, and should not be lower than the measured power. If the power has a tolerance then we also need to check that the measured power is within the tolerance.

2) The manufacturer configures output power so that the maximum power, after accounting for manufacturing tolerances, will never exceed the maximum power level measured.

3) The output power in the tables above is the maximum power per chain among various channels and various modes within the specific band.

4) The antenna gain in the tables above is the maximum antenna gain among various channels within the specified band.

MIMO and/or Co-located transmitters with different Power Density limits among bands)

Multiple chain or colocated transmitters

Band	(GHz)	0.85	2.4	2.4
Mode		GSM	WLAN	WLAN
Transmitter		Cell	LAT 3	UAT 1
Separation Distance	(cm)	20	20	20
Output Power	(dBm)	32.75	21.50	19.00
Antenna Gain	(dBi)	-1.70	-0.40	-2.20
Source Based EIRP	(mW)	1273.50	128.82	47.86
FCC Power Density	(mW/cm^2)	0.25	0.03	0.01
FCC Power Density Limit	(mW/cm^2)	0.55	1.00	1.00
Fraction of Limit	(%)	46.09	2.56	0.95
Sum of Fractions (%)	49.60			

Multiple chain or colocated transmitters

Band	(GHz)	0.85	2.4	2.4	5	5
Mode		GSM	BT	BT	WLAN	WLAN
Transmitter		Cell	LAT 3	UAT 1	LAT 3	UAT 2
Separation Distance	(cm)	20	20	20	20	20
Output Power	(dBm)	32.75	20.00	19.00	21.00	17.75
Antenna Gain	(dBi)	-1.70	-0.40	-2.20	-0.10	-2.60
Source Based EIRP	(mW)	1273.50	91.20	47.86	123.03	32.73
FCC Power Density	(mW/cm^2)	0.25	0.02	0.01	0.02	0.01
FCC Power Density Limit	(mW/cm^2)	0.55	1.00	1.00	1.00	1.00
Fraction of Limit	(%)	46.09	1.82	0.95	2.45	0.65
Sum of Fractions (%)	52.09					

END OF REPORT