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

MPE REPORT

FOR

SMARTPHONE

MODEL NUMBER: A1897

FCC ID: BCG-E3174A
IC: 579C-E3174A

REPORT NUMBER: 11697707-E12V4

ISSUE DATE: AUGUST 31,2017

Prepared for
APPLE, INC.
1 INFINITE LOOP
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Revision History

Rev.	Issue Date	Revisions	Revised By
V1	08/10/2017	Initial Issue	Mengistu Mekuria
V2	08/18/2017	Address TCB's Question	Chin Pang
V3	08/22/2017	Address TCB's Question	Chin Pang
V4	08/31/2017	Address FCC's Question	Mengistu Mekuria

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: SMARTPHONE

MODEL: A1897

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC PART 1 SUBPART I & PART 2 SUBPART J	Pass
INDUSTRY CANADA RSS 102 ISSUE 5	Pass

UL Verification Services Inc. calculated the RF Exposure of the above equipment in accordance with the requirements set forth in the above standards, using test results reported in the test report documents referenced below and/or documentation furnished by the applicant. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations of these calculations. The results show that the equipment 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, or any agency of the U.S. Government.

Approved & Released For
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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 11697707-S1V6 (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.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The Equipment Under Test is a mobile phone with GSM, GPRS, EGPRS, UMTS, LTE and TD-SCDMA technologies. It also supports IEEE 802.11a/b/g/n/ac, Bluetooth®, GPS and NFC. The device has a built-in inductive charging receiver which is not user accessible. The rechargeable battery is 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	33.3	*	*	*
GSM 1900	31.3	**	**	**
WCDMA Band II	25.3	**	**	**
WCDMA Band IV	25.3	**	**	**
WCDMA Band V	24.8	**	**	**
LTE Band 2	24.8	**	**	**
LTE Band 4	24.8	**	**	**
LTE Band 5	24.8	**	**	**
LTE Band 7	24.8	**	**	**
LTE Band 12	24.8	**	**	**
LTE Band 13	24.8	**	**	**
LTE Band 17	24.8	**	**	**
LTE Band 25	24.8	**	**	**
LTE Band 26	24.8	**	**	**
LTE Band 30	23.0	**	**	**
LTE Band 41	24.5	**	**	**
LTE Band 66	24.8	**	**	**

Note: * Worst Case for the Co-located MPE Calculation based on the output powers.
** Not the worst case

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/m^2)**	**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/m^2)**	**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 COLOCATED 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 colocation, 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	33.30	-1.69	1448.8	0.288	2.88
1900 MHz	GSM	20	31.30	0.37	1468.9	0.292	2.92
Band II	WCDMA	20	25.30	0.37	369.0	0.073	0.73
Band IV	WCDMA	20	25.30	-0.02	337.3	0.067	0.67
Band V	WCDMA	20	24.80	-1.69	204.6	0.041	0.41
Band 2	LTE	20	24.80	0.37	328.9	0.065	0.65
Band 4	LTE	20	24.80	-0.02	300.6	0.060	0.60
Band 5	LTE	20	24.80	-1.69	204.6	0.041	0.41
Band 7	LTE	20	24.80	0.05	305.5	0.061	0.61
Band 12	LTE	20	24.80	-2.13	184.9	0.037	0.37
Band 13	LTE	20	24.80	-1.93	193.6	0.039	0.39
Band 17	LTE	20	24.80	-2.13	184.9	0.037	0.37
Band 25	LTE	20	24.80	0.37	328.9	0.065	0.65
Band 26	LTE	20	24.80	-1.69	204.6	0.041	0.41
Band 30	LTE	20	23.00	1.42	276.7	0.055	0.55
Band 41	LTE	20	24.50	0.20	295.1	0.059	0.59
Band 66	LTE	20	24.80	0.44	334.2	0.067	0.67
2.4 GHz	Bluetooth	20	20.00	1.01	126.2	0.025	0.25
2.4 GHz	WLAN	20	21.50	1.01	178.2	0.035	0.35
5 GHz	WLAN	20	21.00	0.68	147.2	0.029	0.29

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 Colocated 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 Power Density (W/m^2)**
2.4 GHz	Bluetooth	N/A		20.00	1.01	126.2		
5 GHz	WLAN	UAT2		21.00	0.68	147.2		
5 GHz	WLAN	LAT3		21.00	-0.93	101.6		
Combined			20			674.8	0.134	1.34

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 Power Density (W/m^2)**
2.4 GHz	WLAN	UAT 1		21.50	1.01	178.2		
2.4 GHz	WLAN	LAT 3		21.50	-2.24	84.3		
Combined			20			262.6	0.052	0.52

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 Colocated 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	LAT3	UAT1
Separation Distance	(cm)	20	20	20
Output Power	(dBm)	33.3	21.5	21.5
Antenna Gain	(dBi)	-1.69	-2.24	1.01
Source Based EIRP	(mW)	1448.8	84.3	178.2
FCC Power Density	(mW/cm^2)	0.29	0.02	0.04
FCC Power Density Limit	(mW/cm^2)	0.55	1.00	1.00
IC Power Density	(W/m^2)	2.88	0.17	0.35
IC Power Density Limit	(W/m^2)	5.5	10.0	10.0
Fraction of Limit	(%)	52.43	1.68	3.55
Sum of Fractions (%)	57.78			

Multiple chain or colocated transmitters

Band	(GHz)	0.85	2.4	5	5
Mode		GSM	BT	WLAN	WLAN
Transmitter		Cell	LAT3	LAT3	UAT2
Separation Distance	(cm)	20	20	20	20
Output Power	(dBm)	33.3	20.0	21.0	21.0
Antenna Gain	(dBi)	-1.69	-2.24	-0.93	0.68
Source Based EIRP	(mW)	1448.8	59.7	101.6	147.2
FCC Power Density	(mW/cm^2)	0.29	0.01	0.02	0.03
FCC Power Density Limit	(mW/cm^2)	0.55	1.00	1.00	1.00
IC Power Density	(W/m^2)	2.88	0.12	0.20	0.29
IC Power Density Limit	(W/m^2)	5.5	10.0	10.0	10.0
Fraction of Limit	(%)	52.4	1.2	2.0	2.9
Sum of Fractions (%)	58.7				

END OF REPORT