

FCC RF EXPOSURE EVALUATION REPORT

FCC ID: 2AO38-AP1000-41

Project No. : 1812C016

Equipment : Apex Lifestyle Small Cell

Model : AP1000-41

Applicant : Casa Systems, Inc.

Address : 100 Old River Road Suite 100 Andover,
Massachusetts 01810 United States

Exposure category : General population/uncontrolled environment

EUT Type: : Production Unit (Engineer Sample)

Device Type : Mobile Device

1. Evaluation Method

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0 . The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

2. Limits for General Population/Uncontrolled Exposure

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

3. Refer Evaluation Method

[ANSI C95.1-1999](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[FCC KDB publication 447498 D01 General RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1093](#): Radiofrequency radiation exposure evaluation: portable devices

4. Calculation Method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG / 4\pi R^2$$

Where:

S=power density

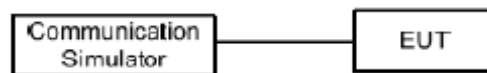
P=power input to antenna

G=power gain of the antenna in the direction of interest relative to an isotropic radiator

R=distance to the center of radiation of the antenna

5. Conducted Power Results

5.1 Test Setup for LTE



Test Setup for WLAN



5.2 Test Equipment

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Wideband Radio Communication Tester	R&S	CMW500	152372	Mar. 11, 2019
2	Power Meter	ANRITSU	ML2495A	MY51000507	Mar.11, 2019
3	Pulse Power Sensor	ANRITSU	MA2411B	1027500	Mar.11, 2019

Remark: all calibration period of equipment list is one year.

5.3 Test Procedure for LTE

- a. Place the EUT on a bench and set it in transmitting mode.
- b. Connect a low loss RF cable from the antenna port to a CMW500 by an Att.
- c. EUT Communicate with CMW500 then selects a channel for testing.

- d. Add a correction factor to the display CMW500, and then test. Reading burst average power in CMW500.

5.4 Test Procedure for WLAN

- The EUT was directly connected to the power meter and antenna output port as show in the block diagram Test Setup.
- Setup EUT work at duty cycle more than 98%;
- Read power sensor values in RMS detector;

5.5 Test Results and Manufacturing Tolerance

Mode	Maximum average power declared by Manufacturer	
	Antenna 0	Antenna 1
IEEE 802.11b	-/-	≤ 24.50
IEEE 802.11g	-/-	≤ 26.00
IEEE 802.11n HT20	≤ 26.00	≤ 26.00
IEEE 802.11n HT40	≤ 24.00	≤ 24.00

5G UNII Band 1 Non-Beamforming

Mode	Maximum average power declared by Manufacturer	
	Antenna 0	Antenna 1
IEEE 802.11a	-/-	≤ 21.00
IEEE 802.11n HT20	≤ 17.00	≤ 18.50
IEEE 802.11n HT40	≤ 16.50	≤ 18.00
IEEE 802.11ac VHT20	≤ 17.00	≤ 18.50
IEEE 802.11ac VHT40	≤ 16.00	≤ 17.50
IEEE 802.11ac VHT80	≤ 14.50	≤ 15.50

5G UNII Band 1 Beamforming

Mode	Maximum average power declared by Manufacturer	
	Antenna 0	Antenna 1
IEEE 802.11n HT20	≤ 17.00	≤ 18.50
IEEE 802.11n HT40	≤ 16.00	≤ 18.00
IEEE 802.11ac VHT20	≤ 17.00	≤ 18.50
IEEE 802.11ac VHT40	≤ 15.50	≤ 17.50
IEEE 802.11ac VHT80	≤ 14.00	≤ 16.00

LTE Band 41

Mode	Maximum average power declared by Manufacturer	
	Antenna 2	Antenna 3
QPSK	≤ 19.00	≤ 19.00
16QAM	≤ 18.00	≤ 18.00
64QAM	≤ 17.00	≤ 17.00

6. Antenna Information

Antenna	Manufacturer	P/N	Antenna Type	Connector	Maximum Peak Gain (dBi)
Antenna 0		SSR-1809026	Internal	IPEX	2.91 @ 2.4 GHz 3.14 @ 5 GHz
Antenna 1		SSR-1805035	Internal	IPEX	2.93 @ 2.4 GHz 3.40 @ 5 GHz
Antenna 2		EmP102-B-I100(G)	PCB	IPEX	3.40
Antenna 3		EmP102-B-I150(G)	PCB	IPEX	3.40

7. Evaluation Results

7.1 Standalone Evaluation

[Antenna 0]

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11n HT20	26.00	398.1072	2.91	1.9953	100%	0.1549	1.0000
	17.00	50.1187	3.14	2.0606	100%	0.0206	1.0000
IEEE 802.11n HT40	24.00	251.1886	2.91	1.9953	100%	0.0977	1.0000
	16.00	39.8107	3.14	2.0606	100%	0.0163	1.0000
IEEE 802.11ac VHT20	17.00	50.1187	3.14	2.0606	100%	0.0206	1.0000
IEEE 802.11ac VHT40	16.00	39.8107	3.14	2.0606	100%	0.0163	1.0000
IEEE 802.11ac VHT80	14.50	28.1838	3.14	2.0606	100%	0.0166	1.0000

[Antenna 1]

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11b	24.50	281.8383	2.93	1.9634	100%	0.1101	1.0000
IEEE 802.11g	26.00	398.1072	2.93	1.9634	100%	0.1556	1.0000
IEEE 802.11n HT20	26.00	398.1072	2.93	1.9634	100%	0.1556	1.0000
	18.50	70.7946	3.40	2.1878	100%	0.0308	1.0000
IEEE 802.11n HT40	24.00	251.1886	2.93	1.9634	100%	0.0982	1.0000
	18.00	63.0957	3.40	2.1878	100%	0.0275	1.0000
IEEE 802.11a	21.00	125.8925	3.40	2.1878	100%	0.0548	1.0000
IEEE 802.11ac VHT20	18.50	70.7946	3.40	2.1878	100%	0.0308	1.0000
IEEE 802.11ac VHT40	17.50	56.2341	3.40	2.1878	100%	0.0245	1.0000
IEEE 802.11ac VHT80	16.00	39.8107	3.40	2.1878	100%	0.0173	1.0000

[Antenna 2]

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
QPSK	19.00	79.4328	3.40	2.1878	67.67%	0.0231	1.0000
16QAM	18.00	63.0957	3.40	2.1878	67.67%	0.0183	1.0000
64QAM	17.00	50.1187	3.40	2.1878	67.67%	0.0145	1.0000

[Antenna 3]

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
QPSK	19.00	79.4328	3.40	2.1878	67.67%	0.0231	1.0000
16QAM	18.00	63.0957	3.40	2.1878	67.67%	0.0183	1.0000
64QAM	17.00	50.1187	3.40	2.1878	67.67%	0.0145	1.0000

Remark:

1. Maximum power including tune-up tolerance;
2. $MPE = PG/4 \cdot \pi \cdot R \cdot R \cdot \text{Duty Cycle}$
3. MPE use distance is 20cm from manufacturer declaration of user manual.

7.2

Simultaneous Transmission for MPE

The sample support one WLAN modular and 2T2R MIMO antennas for 2.4GHz and 5 GHz, 2.4GHz and 5GHz cannot transmit at same time;

The sample also support LTE modular and support 2T2R MIMO antennas.

WLAN and LTE share difference modular and difference antenna, need consider simultaneous transmission.

Antenna 0 and Antenna 1 for WLAN

Band	Mode	MPE Ratio Antenna 0	MPE Ratio Antenna 1	Σ MPE ratios	Limit	Results
2.4GHz	IEEE 802.11b	-/-	0.1101	N/A	1.0	PASS
	IEEE 802.11g	-/-	0.1556	N/A	1.0	PASS
	IEEE 802.11n HT20	0.1549	0.1556	< 0.4	1.0	PASS
	IEEE 802.11n HT40	0.0977	0.0982	< 0.2	1.0	PASS
5GHz	IEEE 802.11a	-/-	0.0548	N/A	1.0	PASS
	IEEE 802.11n HT20	0.0206	0.0308	< 0.1	1.0	PASS
	IEEE 802.11n HT40	0.0163	0.0275	< 0.1	1.0	PASS
	IEEE 802.11ac VHT20	0.0206	0.0308	< 0.1	1.0	PASS
	IEEE 802.11ac VHT40	0.0163	0.0245	< 0.1	1.0	PASS
	IEEE 802.11ac VHT80	0.0166	0.0173	< 0.1	1.0	PASS

Antenna 2 and Antenna 3 for LTE

Band	Mode	MPE Ratio Antenna 0	MPE Ratio Antenna 1	$\sum$ MPE ratios	Limit	Results
LTE Band 41	QPSK	0.0231	0.0231	< 0.1	1.0	PASS
	16QAM	0.0183	0.0183	< 0.1	1.0	PASS
	64QAM	0.0145	0.0145	< 0.1	1.0	PASS

Maximum MPE Ratios for WLAN and LTE simultaneous transmission

Maximum MPE Ratio _{2.4G WLAN}	Maximum MPE Ratio _{5G WLAN}	$\sum$ MPE ratios	Limit	Results
< 0.4	< 0.1	< 0.5	1.0	PASS

Remark:

1. Maximum power including tune-up tolerance;
2. MPE use distance is 20cm from manufacturer declaration of user manual.

8. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1093 for the uncontrolled RF Exposure and SAR Exclusion Threshold per KDB 447498 v06.

----- END OF REPORT -----