

RF Exposure Evaluation Report

APPLICANT : CASA SYSTEMS,INC.
EQUIPMENT : Apex Enterprise Femto cell (E-Femto)
(B4/B13/B66 Plus N48/N77)
BRAND NAME : APEX Femto for Enterprise (eFemto)
MODEL NAME : 5G2101-48
FCC ID : 2AO385G2101-48
STANDARD : 47 CFR Part 2.1091

The product evaluation date was started from Nov. 01, 2022 and completed on Dec. 03, 2022. We, Sporton International Inc. (Kunshan), would like to declare that the device has been evaluated in accordance with 47 CFR Part2.1091, and pass the limit. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.



Approved by: Si Zhang

Sporton International Inc. (Kunshan)

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People's Republic of China**



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1. Administration Data

1.1. Testing Laboratory

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Testing Laboratory			
Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	SAR01-KS	CN1257	314309

Applicant	
Company Name	CASA SYSTEMS,INC.
Address	100 Old River Road Andover MA 01810 USA

Manufacturer	
Company Name	CASA SYSTEMS,INC.
Address	100 Old River Road Andover MA 01810 USA

2. Guidance Applied

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC 47 CFR Part 2.1091
- KDB 447498 D04 Interim General RF Exposure Guidance v01
- FCC 47 CFR Part 1.1307

3. Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT Type	Apex Enterprise Femto cell (E-Femto) (B4/B13/B66 Plus N48/N77)
Brand Name	APEX Femto for Enterprise (eFemto)
Model Name	5G2101-48
FCC ID	2AO385G2101-48
Wireless Technology and Frequency Range	LTE Band 4 : 2110 MHz ~ 2155 MHz LTE Band 13 : 746 MHz ~ 756 MHz LTE Band 66 : 2110 MHz ~ 2180 MHz 5G NR n77 : 3700 MHz ~ 3980 MHz 5G NR n48: 3550MHz ~ 3700MHz
Mode	LTE: QPSK / 16QAM / 64QAM / 256QAM 5G NR: CP-OFDM (64QAM / 256QAM)
Antenna Gain	Internal Antenna: Ant1: LTE Band 4 : 3.85 dBi LTE Band 13 : 0.94 dBi LTE Band 66: 4.06 dBi Ant2: LTE Band 4 : 4.71 dBi LTE Band 13 : 1.01 dBi LTE Band 66: 4.71 dBi Ant3: 5G NR n77 : 6.18 dBi 5G NR n48 : 6.18 dBi Ant4: 5G NR n77 : 7.35 dBi 5G NR n48 : 6.22 dBi External Antenna: Ant1/2: LTE Band 4 : 8.80 dBi LTE Band 13 : 7.90 dBi LTE Band 66: 8.80 dBi Ant3/4: 5G NR n77 : 8.00 dBi 5G NR n48 : 8.00 dBi
Antenna Type	WWAN External Antenna : Directional Antenna WWAN Internal Antenna : PIFA Antenna
HW Version	V02
SW Version	R1.0
EUT Stage	Production Unit

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. WWAN support SISO/MIMO mode, the Internal Antenna and External Antenna support manual switch, the Internal & External antenna can't work at the same time.
3. This device supports HPUE for 5G NR n77/n48 with class 2 power level, so HPUE has been performed MPE calculation.
4. This is a variant report. The difference between current project and previous project referred to the Class II Permissive Change letter which is exhibit separately. According to the difference, only added 5GNR n48 re-evaluation based on original report FA 282511.

Comments and Explanations:

1. The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.
2. The maximum RF output tune up power, antenna gain also the safe distance used for evaluate RF exposure were declared by manufacturer.



4. Maximum RF average output tune up power among production units

<LTE>

<Internal Antenna>

Mode		Maximum Average power(dBm)		
		Ant1	Ant2	Ant1+2
LTE	Band 4	22.00	22.00	25.00
	Band 13	21.00	21.00	25.00
	Band 66	22.00	22.00	25.00

<External Antenna>

Mode		Maximum Average power(dBm)		
		Ant1	Ant2	Ant1+2
LTE	Band 4	22.00	22.00	25.00
	Band 13	21.00	21.00	25.00
	Band 66	22.00	22.00	25.00

<5G NR>

<Internal Antenna>

Mode		Maximum Average power(dBm)		
		Ant3	Ant4	Ant3+4
5G NR	n77 PC3	25.00	25.00	28.00
	n77 PC2	28.00	28.00	31.00
	n48 PC3	22.00	22.00	25.00
	n48 PC2	25.00	25.00	28.00

<External Antenna>

Mode		Maximum Average power(dBm)		
		Ant3	Ant4	Ant3+4
5G NR	n77 PC3	25.00	25.00	28.00
	n77 PC2	28.00	28.00	31.00
	n48 PC3	22.00	22.00	25.00
	n48 PC2	25.00	25.00	28.00

Note: WWAN support SISO/MIMO mode, we only chose MIMO tune up power to perform MPE calculation conservatively for MIMO power is higher.



5. RF Exposure Limit Introduction

1. Per 1.1307(b)(3), (i) For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold Pth (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). Pth is given by:

Pth (mW) = { ERP20 cm (d/20 cm)^x d <= 20 cm
ERP20 cm 20 cm < d <= 40 cm [1]

Where x = - log10(60 / (ERP20 cm * sqrt(f))) and f is in GHz [2]

and ERP20 cm (mW) = { 2040f 0.3 GHz < f <= 1.5 GHz
3060 1.5 GHz < f <= 6 GHz [3]

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least lambda/2pi, where lambda is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of lambda/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value)

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

Table with 2 columns: RF Source frequency (MHz) and Threshold ERP (watts). Rows include frequency ranges like 0.3-1.34, 1.34-30, 30-300, 300-1,500, and 1,500-100,000 with corresponding ERP formulas.



2. For multiple RF sources: Multiple RF sources are exempt if:

- (A) The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).
- (B) In the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

- a. a = number of fixed, mobile, or portable RF sources claiming exemption using the § 1.1307(b)(3)(i)(B) formula for Pth, including existing exempt transmitters and those being added.
- b. b = number of fixed, mobile, or portable RF sources claiming exemption using the applicable § 1.1307(b)(3)(i)(C) Table 1 formula for Threshold ERP, including existing exempt transmitters and those being added.
- c. c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance.
- d. Pi, the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive)
- e. Pth,i the exemption threshold power (Pth) according to the § 1.1307(b)(3)(i)(B) formula for fixed, mobile, or portable RF source i.
- f. ERPj the available maximum time-averaged power or the ERP, whichever is greater, of fixed, mobile, or portable RF source j.
- g. ERPth,j exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question.
- h. Evaluatedk the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation.
- i. Exposure Limitk either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable sources RF source k, as applicable from § 1.1310 of this chapter.
- j. The relationship between EIRP and ERP is: ERP (dBm) = EIRP - 2.15, Where EIRP is the sum of the conducted power (dBm) and the antenna gain (dBi)

The sum of the ratios of the applicable terms for SAR-based, MPE-based and measured SAR or MPE shall be less than 1, to determine simultaneous transmission exposure compliance



6. Radio Frequency Radiation Exposure Evaluation

6.1. Standalone assessment

<Internal Antenna>

Band	Antenna Gain (dBi)	Maximum Conducted Power (dBm)	Duty cycle	Maximum EIRP (dBm)	Maximum ERP (dBm)	Maximum ERP (mW)	Separation Distance (cm)	Part1.1307 option(c) Threshold (mW)	Part1.1307 option(c) ERP/ERPth
LTE Band 4 MIMO	4.71	25.00	100.00%	29.71	27.56	570.16	58	6458.880	0.088
LTE Band 13 MIMO	1.01	25.00	100.00%	26.01	23.86	243.22	58	3212.216	0.076
LTE Band 66 MIMO	4.71	25.00	100.00%	29.71	27.56	570.16	58	6458.880	0.088
5G NR n77 MIMO	7.35	31.00	80.00%	37.35	35.20	3311.31	58	6458.880	0.513
5G NR n48 MIMO	6.22	28.00	80.00%	33.22	31.07	1279.38	58	6458.880	0.198

<External Antenna>

Band	Antenna Gain (dBi)	Maximum Conducted Power (dBm)	Duty cycle	Maximum EIRP (dBm)	Maximum ERP (dBm)	Maximum ERP (mW)	Separation Distance (cm)	Part1.1307 option(c) Threshold (mW)	Part1.1307 option(c) ERP/ERPth
LTE Band 4 MIMO	8.80	25.00	100.00%	33.80	31.65	1462.18	58	6458.880	0.226
LTE Band 13 MIMO	7.90	25.00	100.00%	32.90	30.75	1188.50	58	3212.216	0.370
LTE Band 66 MIMO	8.80	25.00	100.00%	33.80	31.65	1462.18	58	6458.880	0.226
5G NR n77 MIMO	8.00	31.00	80.00%	38.00	35.85	3845.92	58	6458.880	0.595
5G NR n48 MIMO	8.00	28.00	80.00%	35.00	32.85	1927.52	58	6458.880	0.298

Note:

1. Chose the maximum power to do MPE analysis.
2. Chose the higher SISO gain as MIMO gain to perform MPE calculation.
3. For 5G NR Evaluation, using perform MPE analysis with default 80% (Declared by Manufacturer) transmission.



6.2. Simultaneous Transmission MPE Test Exemption

<Internal Antenna>

LTE ERP/ERPth Ratio	5GNR ERP/ERPth Ratio	Sum of the Ratio LTE + 5GNR
0.088	0.513	0.601

<External Antenna>

LTE ERP/ERPth Ratio	5GNR ERP/ERPth Ratio	Sum of the Ratio LTE + 5GNR
0.370	0.595	0.965

Note:

1. For colocation analysis of Internal Antenna, LTE Band 66 is chosen for summation due to the highest ERP/ERPth Ratio among all LTE Band modes.
2. For colocation analysis of Internal Antenna, 5GNR n77 is chosen for summation due to the highest ERP/ERPth Ratio among all 5GNR Band modes.
3. For colocation analysis of External Antenna, LTE Band 13 is chosen for summation due to the highest ERP/ERPth Ratio among all LTE Band modes.
4. For colocation analysis of External Antenna, 5GNR n77 is chosen for summation due to the highest ERP/ERPth Ratio among all 5GNR Band modes.
5. WWAN support SISO/MIMO mode, the Internal Antenna and External Antenna support manual switch, the Internal & External antenna can't work at the same time.
6. According to Part1.1307 (b)(3)(i)(C), the ERP/ERPth Ratio is using for Sim-Tx analysis, above table was showing summation ratio is smaller than 1.
7. The device support LTE + 5G NR simultaneous transmission mode, they also support LTE MIMO + 5G NR MIMO simultaneous transmission mode.

Conclusion:

According to 47 CFR §1.1307 (b)(3)(i)(C), the RF exposure analysis concludes that the RF Exposure is FCC compliant.

-----THE END-----