Radio Frequency Exposure Evaluation Report

For:

Astronautics

Model Name:

AEC115

Product Description:

The AEC115 is an air vehicle equipment for recording and transferring of collected data via cellular and Wi-Fi radio while the vehicle is on the ground.

Applied Rules and Standards:
CFR Part 1.1307 & 1.1310, Part 2.1091
ISEDC RSS-102 Issue 5

Report number: EMC_ASTRO-019-22001_FCC_MPE_Rev2
DATE: 1-27-2023

A2LA Accredited

IC recognized #
3462B-1

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1. Assessment

This RF Exposure evaluation report provides information about compliance of the below identified device with the RF Exposure limits for mobile devices as defined in FCC CFR Part 1 (1.1307 &1.1310), Part 2 (2.1091), and ISEDC standard RSS-102, under given conditions (measured or rated RF output power, antenna gain, distance towards human body, multiple transmitter information as presented by the applicant). In addition, maximum antenna gain or minimum distance towards the human body is calculated, respectively, where relevant.

The device meets the limits as stipulated by the above given FCC/ISEDC rule parts based on available specifications.

Company Name	Product Description	Model #
Astronautics	The AEC115 is an air vehicle equipment for recording and transferring of collected data via cellular and Wi-Fi radio while the vehicle is on the ground. The UNII1 band 5150-5250 is disabled for ISED.	AEC115

Responsible for Testing Laboratory:

Date	Section	Name	Signature
1-27-2023	Compliance	Arndt Stoecker (Director of Regulatory Services)	Arndt Stoecker Digitally signed by: Arndt Stoecker DN: CN = Arndt Stoecker email = arndt.stoecker@cetecom.com C = US O = CETECOM Inc Date: 2023.01.30 16:57:03 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
1-27-2023	Compliance	Kris Lazarov (Senior EMC Engineer)	Kris Lazarov Digitally signed by Kris Lazarov Date: 2023.01.27 10:13:02 -08'00'

Contents

2. Administrative Data

2.1. Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Director of Regulatory Services:	Arndt Stoecker
Responsible Project Leader:	Cathy Palacios

2.2. Identification of the Client

Applicant's Name:	Astronautics
Street Address:	135 W Forest Hill Avenue
City/Zip Code	Oak Creek, WI 53154-0121
Country	United States

2.3. Identification of the Manufacturer

Manufacturer's Name:	Same as Client
Manufacturers Address:	
City/Zip Code	
Country	

3. Equipment under Assessment

Model No	AEC115
HW Version	282300
SW Version	282283
Cellular Module	FCC ID: N7NEM75 / ISED ID: 2417C-EM75
WLAN Module	FCC ID: RYK-WPEQ256ACN / ISED ID: 6158A-WPEQ256ACN
Product Description	The AEC115 is an air vehicle equipment for recording and transferring of collected data via cellular and Wi-Fi radio while the vehicle is on the ground.
Transceiver Technology	- UMTS Bands II, IV, V - LTE Bands 2, 4, 5, 12, 13, 26, 29, 41, 66 - 802.11a/b/g/n/ac 2.4 GHz; UNII-1; UNII-3 – See Note
Co-located Transmitters/ Antennas?	Cellular with WLAN can transmit simultaneously
Power Supply/ Rated Operating Voltage Range	28VDC
Operating Temperature Range	-40 ºC to 55 ºC
Sample Revision	☐Prototype ■Production ☐ Pre-Production
Device Category	☐Fixed Installation ■Mobile ☐Portable
Exposure Category	☐ Occupational/ Controlled ■ General Population/ Uncontrolled

Note: The UNII1 band 5150-5250 is disabled for ISED.

Radio Technology	Maximum Power (dBm)	Peak Gain (dBi)
LTE Bands 2, 4, 5, 12, 13, 26, 66	23 ± 1	6
LTE Bands 41	22 ± 1	6
UMTS Bands II, IV, V	23 ± 1	6
WLAN 2.4GHz, 2.4 - 2.48GHz	20 ± 2	4
WLAN 5GHz, 5.15 – 5.25GHz	16 ± 2	6.11
WLAN 5GHz, 5.735 – 5.815GHz	16 ± 2	6.11

Note: The power and antenna gain information were provided by the customer in Document No: 284826-USG-A

4. RF Exposure Evaluation Methods

4.1. RF Exposure Test Exemptions for Single Source

1.4.1. FCC § 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.

Single RF sources as defined in paragraph (b)(2) of FCC § 2.1091 is exempt if the ERP (watts) is no more than the calculated value prescribed for that frequency. General frequency and separation-distance dependent MPE-based effective radiated power ERP thresholds are in Table B.1 [Table 1 of § 1.1307(b)(3)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

TABLE B.1—THRESHOLDS FOR SINGLE RF SOURCES
SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source Frequency			Minimum Distance			Threshold ERP
f_L MHz		f_H MHz	$\lambda_L / 2\pi$		$\lambda_H / 2\pi$	W
0.3	–	1.34	159 m	–	35.6 m	1,920 R^2
1.34	–	30	35.6 m	–	1.6 m	3,450 R^2/f^2
30	–	300	1.6 m	–	159 mm	3.83 R^2
300	–	1,500	159 mm	–	31.8 mm	0.0128 R^2f
1,500	–	100,000	31.8 mm	–	0.5 mm	19.2R2
Subscripts L and H are low and high; λ is wavelength. From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.						

2.4.1. Exemption Limits for Routine Evaluation to RSS-102 2.5.2

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $1.31 \times 10^{-2}\ f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

4.2. RF Exposure Test Exemptions for Simultaneous Transmission Sources

Multiple RF sources are exempt if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation:

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

Where:
a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for P_{th}, including existing exempt transmitters and those being added.
b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section for Threshold ERP, including existing exempt transmitters and those being added.
c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.
P_i = 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).
$P_{th,i}$ = the exemption threshold power (P_{th}) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source *i.*
ERP_j = the ERP of fixed, mobile, or portable RF source *j.*
$ERP_{th,j}$ = exemption threshold ERP for fixed, mobile, or portable RF source *j,* at a distance of at least λ/2π according to the applicable formula of paragraph (b)(3)(i)(C) of this section.
$Evaluated_k$ = 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 at the location of exposure.
$Exposure\ Limit_k$ = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source *k,* as applicable from § 1.1310 of this chapter.

5. Evaluations

5.1. Compliance with MPE (Power Density) limits

Power Density Calculation						
Band of Operation MHz	**EIRP** dBm	**Maximum Duty Cycle** %	**Power Density** mW/cm^2	**ISED Limit** mW/cm^2	**FCC Limit** mW/cm^2	**Verdict**
FDD II	30	1:1	0.109	0.458	1.000	Pass
FDD IV	30	1:1	0.109	0.432	1.000	Pass
FDD V	30	1:1	0.109	0.263	0.566	Pass
LTE 2	30	1:1	0.109	0.458	1.000	Pass
LTE 4	30	1:1	0.109	0.432	1.000	Pass
LTE 5	30	1:1	0.109	0.263	0.566	Pass
LTE 12	30	1:1	0.109	0.234	0.477	Pass
LTE 13	30	1:1	0.109	0.250	0.525	Pass
LTE 26	30	1:1	0.109	0.263	0.566	Pass
LTE 41	29	1:1	0.087	0.578	1.000	Pass
LTE 66	30	1:1	0.109	0.432	1.000	Pass
802.11 2.4 GHz	26	1:1	0.045	0.547	1.000	Pass
802.11 5 GHz	24.11	1:1	0.028	0.992	1.000	Pass

Note 1: All calculations are with the manufacturer declared minimum of 27cm distance between the antenna and the human body.
Note 2: LTE Band 29 is a downlink only band and is excluded from this evaluation.

Conclusion:

- The equipment fulfills the MPE limits for the minimum 27cm distance between the antenna and the human body

5.2. Routine Environmental Evaluation Applicability Simultaneous Transmission

- Theoretically the worst case of simultaneous transmission is with the three transmitters operating at the highest output power mode, within the nearest frequency bands (Wi-Fi 2.4 + LTE B4).

Transmission Mode	**Sum of the ratios for the highest Power Densities**	**Limits for the Highest Combined Ratio**	**Exempt from Routine evaluation**
2xWi-Fi + LTE B2	0.05 + 0.2 = 0.25	< 1	Yes

Note: Power Density to Applicable limit for Stand Alone Operation are derived from table in section 5.1

Conclusion:

- The equipment is excluded from simultaneous transmission MPE test.

6. Revision History

Date	Report Name	Changes to report	Report prepared by
6-10-2022	EMC_ASTRO-019-22001_FCC_MPE	Initial Version	Kris Lazarov
11-28-2022	EMC_ASTRO-019-22001_FCC_MPE_Rev1	Corrected the UNII antenna gain in section 3; Corrected the UNII calculation in table 5.1	Kris Lazarov
1-27-2023	EMC_ASTRO-019-22001_FCC_MPE_Rev2	Added note that UNII1 is disabled for ISED	Kris Lazarov

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