Radio Frequency Exposure Evaluation Report

For:

Astronautics

Model Name:

AFS6460

Product Description:

Connectivity Module

FCC ID: 2AVRR-AGCS-AFS6460
ISED ID: 25923-AFS6460

Applied Rules and Standards:
CFR Part 1 (1.1307 & 1.1310), Part 2 (2.1091)
ISEDC RSS-102 Issue 5

Report number: EMC_ASTRO-001-20001_FCC_MPE_Rev 1
DATE: 2020-07-07

A2LA Accredited

IC recognized # 3462B-1

***CETECOM* Inc.**
411 Dixon Landing Road ◆ Milpitas, CA 95035 ◆ U.S.A.
Phone: + 1 (408) 586 6200 ◆ Fax: + 1 (408) 586 6299 ◆ E-mail: info@cetecom.com ◆ http://www.cetecom.com
CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

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	Connectivity Module	AFS6460

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2020-09-14	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by cindy.li@cetecom.com DN: CN=cindy.li@cetecom.com Reason: I have reviewed this document Location: Date: 2020-09-14 19:28:21

Responsible for the Report:

Date	Section	Name	Signature
2020-09-14	Compliance	Kris Lazarov (Senior EMC Engineer)	Kris Lazarov Digitally signed by Kris Lazarov Date: 2020.09.14 17:50:17 -07'00'

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
Compliance Manager:	Cindy Li
Responsible Project Leader:	Kris Lazarov

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:	Astronautics
Manufacturers Address:	1426 W National Ave
City/Zip Code	Milwaukee, WI 53204
Country	United States

3. Equipment under Assessment

Model No	AFS6460
HW Version	278830-1
SW Version	282306-0002
Cellular Module	FCC ID: N7NEM7455 / IC ID: 10301A-EM7455A
WiFi Module	FCC ID: RYK-WPEQ256ACNI / IC ID: 25923-AFS6460
Product Description	Connectivity Module
Transceiver Technology	- UMTS Bands II / IV / V - LTE Bands 2,4,5,7,12,13,25,26,29,41 - 802.11 b/g/n/ac 2.4 GHz; UNII-1; UNII-3
Co-located Transmitters/ Antennas?	Cellular with two WiFi can transmit simultaneously
Power Supply/ Rated Operating Voltage Range	- 37V to - 57V – Nominal - 48V
Operating Temperature Range	-40 ºC to 65 ºC
Sample Revision	☐Prototype ■Production ☐ Pre-Production
Device Category	☐Fixed Installation ■Mobile ☐Portable
Exposure Category	☐ Occupational/ Controlled ■ General Population/ Uncontrolled

Note 1: This devise incorporates two identical Sparklan certified modules model number: WPEQ-256ACNI. One module is configured to operate as access point (WAP), and the other operates as WLAN station.

3.1. Antenna Information

Antenna	Radio Technology	Peak Gain (dBi)
LTE External multi-band	LTE and UMTS Bands	6
	WLAN 2.4GHz, 2.4 - 2.5GHz	4
	WLAN 5GHz, 4.8 – 5.825GHz	3.2

4. RF Exposure Limits

For the specific described radio apparatus the following basic limits and rules apply

4.1. Power Density Limits acc. to FCC 1.1310(e)

Frequency Range (MHz)	Power density (mW/cm²)	Averaging time (minutes)
300-1500	f/1500	30
1500 – 100.000	1.0	30

4.2. Routine Environmental Evaluation Categorical Exclusion Limits acc. to FCC 2.1091(c)

- Operating frequency < 1.5GHz: excluded if ERP < 1.5W / 31.8dBm
- Operating frequency > 1.5GHz: excluded if ERP < 3.0W / 34.8dBm

Per KDB 447498 D01 FCC allows calculative estimation of RF exposure for mobile applications when routine environmental evaluation categorical exclusion applies and also for fixed applications.

4.3. 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 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;
- Operating frequency > 300MHz < 6GHz: excluded if ERP < 2.7W / 34.3dBm;

4.4. Exposure Limits RSS-102 4

For the purpose of this standard, ISEDC has adopted the SAR and RF field strength limits established in Health Canada's RF exposure guideline, Safety Code 6

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m2)	Reference Period (minutes)
300-6000	3.142 f 0.3417	0.008335 f 0.3417	0.02619 f 0.6834	6

4.5. RF Exposure Estimation (MPE Estimation)

Having available the source based average output power and peak antenna gain or the ERP/EIRP of the specified device and for a known minimum distance of its radiating structures from the body of persons according to its use cases (at least 20cm) the power density at that distance can be estimated by the following formula for plane-wave equivalent conditions (far-field conditions), when ground reflection is neglected.

$$S = \frac{PG}{4\pi R^2}$$

Where: S = power density (mW/cm² or W/m²)
P = power input to the antenna (mW or W)
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 (cm or m)

5. Evaluations

Cellular power levels and antenna gain was provided by the customer in the "Interface Control Document PN 278760-()" The 802.11 power levels were taken from Sparklan modular reports.

5.1. Compliance with MPE (Power Density) limits

Power Density Calculation							
Band of Operation MHz	**EIRP** dBm	**Maximum Duty Cycle** %	**Distance** cm	**Power Density** mW/cm²	**ISED Limit** mW/cm²	**FCC Limit** mW/cm²	**Verdict**
FDD II	30	1:1	20	0.199	0.458	1.000	Pass
FDD IV	30	1:1	20	0.199	0.432	1.000	Pass
FDD V	30	1:1	20	0.199	0.263	0.566	Pass
LTE 2	30	1:1	20	0.199	0.458	1.000	Pass
LTE 4	30	1:1	20	0.199	0.432	1.000	Pass
LTE 5	30	1:1	20	0.199	0.263	0.566	Pass
LTE 7	29	1:1	20	0.158	0.460	1.000	Pass
LTE 12	30	1:1	20	0.199	0.234	0.477	Pass
LTE 13	30	1:1	20	0.199	0.250	0.525	Pass
LTE 25	30	1:1	20	0.199	0.458	1.000	Pass
LTE 26	30	1:1	20	0.199	0.263	0.566	Pass
LTE 41	29	1:1	20	0.158	0.578	1.000	Pass
802.11 2.4 GHz AP	25.13	1:1	20	0.065	0.547	1.000	Pass
802.11 2.4 GHz Client	27.26	1:1	20	0.106	0.547	1.000	Pass
802.11 5 GHz AP	22.07	1:1	20	0.032	0.992	1.000	Pass
802.11 5 GHz Client	25.98	1:1	20	0.078	0.992	1.000	Pass

Conclusion:

- The equipment fulfills the MPE limits for the minimum 20cm distance between the antenna and the human body

5.2. Routine Environmental Evaluation Applicability Simultaneous Transmission

- Possible simultaneous transmissions: According to the manufacturer the two identical Wi-Fi radio modules incorporated within the device operate simultaneously with the Cellular module. 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 AP + Wi-Fi 2.4 Client + LTE B2).

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	0.12 + 0.19 + 0.43 = 0.74	< 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
2020-04-02	EMC_ASTRO-001-20001_FCC_MPE	Initial Version	Kris Lazarov
2020-04-02	EMC_ASTRO-001-20001_FCC_MPE_Rev 1	Updated the antenna information in section 3.1 Removed the routine evaluation exclusion in section 5 Updated the table in section 5.1 Updated the table in section 5.2	Kris Lazarov

<< The End >>