



# 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)

ISED RSS-102 Issue 5

Report number: EMC\_ASTRO-001-20001\_FCC\_MPE\_Rev 1

DATE: 2020-07-07



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IC recognized #  
3462B-1

## **CETECOM Inc.**

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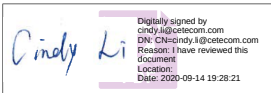
## 1. Assessment

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 ISED 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/ISED rule parts based on available specifications.

| Company Name | Product Description | Model # |
|--------------|---------------------|---------|
| Astronautics | Connectivity Module | AFS6460 |

### Responsible for Testing Laboratory:

| 2020-09-14 | Compliance | Cindy Li<br>(EMC Lab Manager) |  |
|------------|------------|-------------------------------|---------------------------------------------------------------------------------------|
| Date       | Section    | Name                          | Signature                                                                             |

### Responsible for the Report:

| 2020-09-14 | Compliance | Kris Lazarov<br>(Senior EMC Engineer) |  |
|------------|------------|---------------------------------------|---------------------------------------------------------------------------------------|
| Date       | Section    | Name                                  | Signature                                                                             |

The test results of this test report relate exclusively to the test item specified in Section 3.

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## **2. Administrative Data**

### **2.1. Identification of the Testing Laboratory Issuing the Test Report**

|                                    |                        |
|------------------------------------|------------------------|
| <b>Company Name:</b>               | CETECOM Inc.           |
| <b>Department:</b>                 | Compliance             |
| <b>Street Address:</b>             | 411 Dixon Landing Road |
| <b>City/Zip Code</b>               | Milpitas, CA 95035     |
| <b>Country</b>                     | USA                    |
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| <b>Fax:</b>                        | +1 (408) 586 6299      |
| <b>Compliance Manager:</b>         | Cindy Li               |
| <b>Responsible Project Leader:</b> | Kris Lazarov           |

### **2.2. Identification of the Client**

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

### **2.3. Identification of the Manufacturer**

|                               |                     |
|-------------------------------|---------------------|
| <b>Manufacturer's Name:</b>   | Astronautics        |
| <b>Manufacturers Address:</b> | 1426 W National Ave |
| <b>City/Zip Code</b>          | Milwaukee, WI 53204 |
| <b>Country</b>                | United States       |

### 3. Equipment under Assessment

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

**Note 1:** This device 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/cm <sup>2</sup> ) | 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  $1.31 \times 10^{-2} f^{0.6834}$  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, ISED 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/m <sup>2</sup> ) | 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/cm<sup>2</sup> or W/m<sup>2</sup>)

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/cm <sup>2</sup> | ISED Limit mW/cm <sup>2</sup> | FCC Limit mW/cm <sup>2</sup> | 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<br>1 | Updated the antenna<br>information in section 3.1<br>Removed the routine evaluation<br>exclusion in section 5<br>Updated the table in section 5.1<br>Updated the table in section 5.2 | Kris Lazarov       |

<< The End >>