



Radio Frequency Exposure Evaluation Report

FOR:

Particle Industries, Inc.

Model Number:

B404X

Product Description:

LTE CAT-M1 (NorAm) with EtherSIM

FCC ID: 2AEMI-B404X

IC: 20127-B404X

Per:

CFR Part Part1 (1.1307 &1.1310), Part 2 (2.1091),
FCC KDB 447498 D01 General RF Exposure Guidance v06
ISED RSS-102 Issue 5

Report number: EMC_PARTI-002-21001_FCC_ISED_MPE

DATE: 2023-03-10



CETECOM Inc.

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1 Assessment

This RF Exposure evaluation report provides evidence for 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 IC standard RSS-102 issue 5 under worst case 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 and IC rule parts based on available specifications for worst case conditions at 20cm distance to the body.

| Company | Description | Model # |
|---------------------------|----------------------------------|---------|
| Particle Industries, Inc. | LTE CAT-M1 (NorAm) with EtherSIM | B404X |

Report reviewed by: TCB Evaluator

2023-03-10 Compliance Arndt Stoecker
 (Director of Regulatory Services)

| Date | Section | Name | Signature |
|------|---------|------|-----------|
|------|---------|------|-----------|

Responsible for the Report:

2023-03-10 Compliance Cheng Song
 (EMC Engineer)

| Date | Section | Name | Signature |
|------|---------|------|-----------|
|------|---------|------|-----------|

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 |
| Lab Manager: | Arndt Stoecker |
| Responsible Project Leader: | Phillip Quintal |

2.2 Identification of the Client / Manufacturer

| | |
|------------------------|---------------------------|
| Client's Name: | Particle Industries, Inc. |
| Street Address: | 325 9th St |
| City/Zip Code | San Francisco, CA 94103 |
| Country | USA |

Identification of the Manufacturer

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

3 Equipment under Assessment

| | |
|---|---|
| Model Number: | B404X |
| HW Version : | V1.3.0 |
| SW Version : | V4.0.0 |
| Product Marketing Name (PMN): | B Series |
| Radio Information: | <p>Cellular:</p> <ul style="list-style-type: none"> • u-blox SARA-R510S • FCC ID: XPYUBX19KM01; IC: 8595A-UBX19KM01 <p>Bluetooth:</p> <ul style="list-style-type: none"> • Nordic Semiconductor nRF52840 SoC • Bluetooth 5 LE |
| Antenna Information: | <p>Cellular:</p> <ul style="list-style-type: none"> • G142-10006-A antenna • Wide band FPC antenna: 3.86dBi max gain <p>Bluetooth:</p> <ul style="list-style-type: none"> • PCB antenna: 2dBi max gain |
| Power Supply/ Rated Operating Voltage Range: | VCC 3.6V~4.2V Typ 3.6V 3V3 3.3V~3.6V Typ 3.3V VBUS 4.35V~5.5V Typ 5V |
| Operating Temperature Range: | Normal operating temperature: Tmin: -20°C / Tmax: 65°C / Tnom: 25°C Extended operating temperature: Tmin: -40°C / Tmax: 85°C |
| Sample Revision: | <input type="checkbox"/> Prototype Unit; <input type="checkbox"/> Production Unit; <input checked="" type="checkbox"/> Pre-Production |

4 RF Exposure Limits and FCC and IC Basic Rules

For the specific described radio apparatus the following basic limits and rules apply for both, FCC and IC where not indicated differently.

4.1 Power Density Limits acc. to FCC 1.1310(e) / RSS-102 i5, cl. 4:

FCC

| Frequency Range (MHz) | Power density (mW/cm ²) | Averaging time (minutes) |
|-----------------------|-------------------------------------|--------------------------|
| 300 – 1500 | f (MHz) /1500 | 30 |
| 1500 – 100000 | 1.0 | 30 |

IC

| | | |
|------------|-------------------------------------|---|
| 300 – 6000 | 0.02619 x f (MHz) ^{0.6834} | 6 |
|------------|-------------------------------------|---|

4.2 Routine Environmental Evaluation Categorical Exclusion Limits acc. to FCC 2.1091(c) / RSS-102, cl. 2.5 (rounded to 1 decimal point):

FCC

operating frequency < 1.5GHz: excluded if ERP < 1.5W / 31.8dBm (EIRP: 33.9 dBm);
 operating frequency > 1.5GHz: excluded if ERP < 3.0W / 34.8dBm (EIRP: 36.9 dBm);

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

IC

300MHz <= operating frequency < 6 GHz: excluded if EIRP < 0.0131 x f (MHz)^{0.6834} W

4.3 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

5.1 Analysis of RF Exposure

FCC:

LTE 2

Operating frequency > 1.5GHz, ERP20cm Limit = 3060mW = 3.06W
Actual ERP = 0.469W < 3.06W; Excluded.

LTE 4

Operating frequency > 1.5GHz, ERP20cm Limit = 3060mW = 3.06W
Actual ERP = 0.469W < 3.06W; Excluded.

LTE 5

Operating frequency < 1.5GHz, ERP20cm Limit = 2040 x 0.824 = 1680.96mW = 1.68W
Actual ERP = 0.469W < 1.68W; Excluded.

LTE 12

Operating frequency < 1.5GHz, ERP20cm Limit = 2040 x 0.699 = 1425.96mW = 1.43W
Actual ERP = 0.469W < 1.43W; Excluded.

LTE 13

Operating frequency < 1.5GHz, ERP20cm Limit = 2040 x 0.777 = 1585.08mW = 1.59W
Actual ERP = 0.469W < 1.59W; Excluded.

BLE

Operating frequency > 1.5GHz, ERP20cm Limit = 3060mW = 3.06W
Actual ERP = 0.004W < 3.06W; Excluded.

IC:

LTE 2

EIRP Limit = $0.0131 \times f \text{ (MHz)}^{0.6834} = 2.24\text{W}$
Actual EIRP = 0.769W < 2.24W; Excluded.

LTE 4

EIRP Limit = $0.0131 \times f \text{ (MHz)}^{0.6834} = 2.12\text{W}$
Actual EIRP = 0.769W < 2.12W; Excluded.

LTE 5

EIRP Limit = $0.0131 \times f \text{ (MHz)}^{0.6834} = 1.29\text{W}$
Actual EIRP = 0.769W < 1.29W; Excluded.

LTE 12

EIRP Limit = $0.0131 \times f \text{ (MHz)}^{0.6834} = 1.15\text{W}$
Actual EIRP = 0.769W < 1.15W; Excluded.

LTE 13

EIRP Limit = $0.0131 \times f \text{ (MHz)}^{0.6834} = 1.24\text{W}$
Actual EIRP = 0.769W < 1.24W; Excluded.

BLE

EIRP Limit = $0.0131 \times f \text{ (MHz)}^{0.6834} = 2.68\text{W}$
Actual EIRP = 0.007W < 2.68W; Excluded.

MPE

| Radio | freq MHz | MaxPower W conducted | MaxPower convert to dBm | Ant Gain dbi | Ant Gain lin | EIRP W calculated | Max Duty Cycle | IC W/m2 | FCC W/m2 | Actual W/m2 | How much of IC limit is used up | How much of FCC limit is used up |
|--------|----------|----------------------|-------------------------|--------------|--------------|-------------------|----------------|---------|--------------|-------------|---------------------------------|----------------------------------|
| LTE 2 | 1850 | 0.316 | 25.000 | 3.86 | 2.43 | 0.769 | 100.00% | 4.476 | 10.000 | 1.530 | 34.18% | 15.30% |
| LTE 4 | 1710 | 0.316 | 25.000 | 3.86 | 2.43 | 0.769 | 100.00% | 4.242 | 10.000 | 1.530 | 36.08% | 15.30% |
| LTE 5 | 824 | 0.316 | 25.000 | 3.86 | 2.43 | 0.769 | 100.00% | 2.576 | 5.493 | 1.530 | 59.42% | 27.85% |
| LTE 12 | 699 | 0.316 | 25.000 | 3.86 | 2.43 | 0.769 | 100.00% | 2.302 | 4.660 | 1.530 | 66.49% | 32.83% |
| LTE 13 | 777 | 0.316 | 25.000 | 3.86 | 2.43 | 0.769 | 100.00% | 2.474 | 5.180 | 1.530 | 61.84% | 29.54% |
| | | | | | | | | | Distance(m)= | 0.200 | | |
| BLE | 2400 | 0.004 | 6.300 | 2 | 1.58 | 0.007 | 100.00% | 5.348 | 10.000 | 0.013 | 0.24% | 0.13% |

5.2 Conclusion:

The worst-case simultaneous transmission is LTE 12 simultaneous with BLE, which is using 32.96% of FCC limit and 66.73% of IC limit. The equipment is passing RF exposure requirements for 20cm distance.

6 Revision History

| Date | Report Name | Changes to report | Prepared by |
|------------|----------------------------------|-------------------|-------------|
| 2023-03-10 | EMC_PARTI-002-21001_FCC_ISED_MPE | Initial Release | Cheng Song |

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