Radio Frequency Exposure Evaluation Report

FOR:
Particle Industries, Inc.

Model:
BRN404X
BORON 404X with BQ24195L (PMIC)

Product Description:
LTE Development Board with EtherSIM

FCC ID: 2AEMI-BRN404X
IC: 20127-BRN404X

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

Report number: EMC_PARTI-001-21001_FCC_ISED_MPE

DATE: 2023-02-28

***CETECOM* Inc.**
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CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

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 Development Board with EtherSIM	BRN404X BORON 404X with BQ24195L (PMIC)

Report reviewed by: TCB Evaluator

Date	Section	Name	Signature
2023-02-28	Compliance	Arndt Stoecker (Director of Regulatory Services)	

Responsible for the Report:

Date	Section	Name	Signature
2023-02-28	Compliance	Cheng Song (EMC Engineer)	cheng.song@cetecom.com Digitally signed by: cheng.song@cetecom.com DN: CN = cheng.song@cetecom.com Date: 2023.02.28 16:46:42 -08'00'

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:	BRN404X, BORON 404X with BQ24195L (PMIC)
HW Version :	V1.5.0
SW Version :	V4.0.0
Product Marketing Name (PMN):	Boron
Radio Information:	**Cellular:** • u-blox SARA-R510S • FCC ID: XPYUBX19KM01; IC: 8595A-UBX19KM01 **Bluetooth:** • Nordic Semiconductor nRF52840 SoC • Bluetooth 5 LE
Antenna Information:	**Cellular:** • G142-10006-A antenna • Wide band FPC antenna: 3.86dBi max gain **Bluetooth:** • PCB antenna: 2dBi max gain
Power Supply/ Rated Operating Voltage Range:	DC 5V from Host Unit or DC 3.7V from Li-ion battery Vmin = 3.4V, Vmax = 4.4V, Vnom = 3.7V
Operating Temperature Range:	Tmin: -20 ºC / Tmax: 60 ºC / Tnom: 25 ºC
Sample Revision:	☐Prototype Unit; ☐Production Unit; ■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/cm²)	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);

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

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 x f (MHz) $^{0.6834}$ = 2.24W
Actual EIRP = 0.769W < 2.24W; Excluded.

LTE 4
EIRP Limit = 0.0131 x f (MHz) $^{0.6834}$ = 2.12W
Actual EIRP = 0.769W < 2.12W; Excluded.

LTE 5
EIRP Limit = 0.0131 x f (MHz) $^{0.6834}$ = 1.29W
Actual EIRP = 0.769W < 1.29W; Excluded.

LTE 12
EIRP Limit = 0.0131 x f (MHz) $^{0.6834}$ = 1.15W
Actual EIRP = 0.769W < 1.15W; Excluded.

LTE 13
EIRP Limit = 0.0131 x f (MHz) $^{0.6834}$ = 1.24W
Actual EIRP = 0.769W < 1.24W; Excluded.

BLE
EIRP Limit = 0.0131 x f (MHz) $^{0.6834}$ = 2.68W
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
2023-02-28	EMC_PARTI-001-21001_FCC_ISED_MPE	Initial Release	Cheng Song

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