RF Exposure Evaluation Report

APPLICANT	:	**Inseego Corp.**
EQUIPMENT	:	**wireless device**
BRAND NAME	:	**Inseego**
MODEL NAME	:	**FX2000-3, FX2000e-3**
FCC ID	:	**PKRISGFX20003**
STANDARD	:	**47 CFR Part 2.1091**
		FCC KDB 447498 D01 v06

We, Sporton International Inc. (Kunshan), would like to declare that the device has been evaluated in accordance with 47 CFR Part 2.1091 and FCC KDB 447498 D01 v06, and pass the limit. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.

Tony Zhang

Reviewed by: Tony Zhang / Supervisor

Kat Yin

Approved by: Kat Yin / Manager

ACCREDITED Cert #5145.02

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Table of Contents

1. ADMINISTRATION DATA 4
1.1. Testing Laboratory 4
2. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT) 5
3. MAXIMUM RF TUNE UP POWER AMONG PRODUCTION UNITS 7
4. RF EXPOSURE LIMIT INTRODUCTION 9
5. RADIO FREQUENCY RADIATION EXPOSURE EVALUATION 10
5.1. Standalone Power Density Calculation 10
5.2. Collocated Power Density Calculation 11

Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA221525	Rev. 01	Initial issue of report	Mar. 16, 2021

1. Administration Data

1.1. Testing Laboratory

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Testing Laboratory			
Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	SAR01-KS	CN1257	314309

Applicant	
Company Name	Inseego Corp.
Address	9710 Scranton Road, Suite 200 San Diego, CA 92121

Manufacturer	
Company Name	MeiG Smart Technology Co., Ltd
Address	Floor 2, Office Building No.5, Lingxia Road, Fenghuang Community, Fuyong Street, Bao 'an District, Shenzhen

2. Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT Type	wireless device
Brand Name	Inseego
Model Name	FX2000-3, FX2000e-3
FCC ID	PKRISGFX20003
Wireless Technology and Frequency Range	WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz WCDMA Band IV: 1712.4 MHz ~ 1752.6 MHz WCDMA Band V: 826.4 MHz ~ 846.6 MHz LTE Band 2: 1850.7 MHz ~ 1909.3 MHz LTE Band 4: 1710.7 MHz ~ 1754.3 MHz LTE Band 5: 824.7 MHz ~ 848.3 MHz LTE Band 7: 2502.5 MHz ~ 2567.5MHz LTE Band 12: 699.7 MHz ~ 715.3 MHz LTE Band 13: 779.5 MHz ~ 784.5 MHz LTE Band 14: 790.5 MHz ~ 795.5 MHz LTE Band 17: 706.5 MHz ~ 713.5 MHz LTE Band 25: 1850.7 MHz ~ 1914.3 MHz LTE Band 26: 814.7 MHz ~ 848.3 MHz LTE Band 30: 2307.5 MHz ~ 2312.5 MHz LTE Band 38: 2572.5 MHz ~ 2617.5 MHz LTE Band 41: 2498.5 MHz ~ 2687.5 MHz LTE Band 42: 3552.5 MHz ~ 3597.5 MHz LTE Band 43: 3652.5 MHz ~ 3672.5 MHz LTE Band 48: 3552.5 MHz ~ 3697.5 MHz LTE Band 66: 1710.7 MHz ~ 1779.3 MHz LTE Band 71: 665.5 MHz ~695.5 MHz 5G NR n2 : 1850 MHz ~ 1910 MHz 5G NR n5 : 824 MHz ~ 849 MHz 5G NR n12 : 699 MHz ~ 716 MHz 5G NR n25 : 1850 MHz ~1915 MHz 5G NR n41 : 2496 MHz ~ 2690 MHz 5G NR n66 : 1710 MHz – 1780 MHz 5G NR n71 : 663 MHz – 698 MHz 5G NR n77: 3700 MHz ~ 3980 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz
Mode	RMC 12.2Kbps HSDPA/HSUPA DC-HSDPA HSPA+ (16QAM uplink is not supported) LTE: QPSK, 16QAM, 64QAM, 256QAM DFT-s-OFDM (PI/2 BPSK / QPSK / 16QAM / 64QAM / 256QAM) CP-OFDM (QPSK / 16QAM / 64QAM / 256QAM) WLAN 2.4GHz 802.11b/g/n/ax HT20/ HT40/ HE20/ HE40 WLAN 5GHz 802.11a/n HT20/HT40 WLAN 5GHz 802.11ac/ax VHT20/VHT40/VHT80/HE20/HE40/HE80
Antenna Gain	**<For WWAN/5G NR>** WCDMA Band II : 3.4 dBi WCDMA Band IV : 3.8 dBi WCDMA Band V : 1.7 dBi LTE Band 2 : 3.4 dBi LTE Band 4 : 3.8 dBi LTE Band 5 : 1.7 dBi LTE Band 7 : 4.6 dBi LTE Band 12 : 0.2 dBi LTE Band 13 : 1.3 dBi LTE Band 14 : 1.7 dBi

	LTE Band 17 : 0.2 dBi LTE Band 25 : 3.4 dBi LTE Band 26 : 1.7 dBi LTE Band 30 : 2.8 dBi LTE Band 38 : 4.3 dBi LTE Band 41 : 4.5 dBi LTE Band 42 : 3.2 dBi LTE Band 43 : 3.3 dBi LTE Band 48 : 3.6 dBi LTE Band 66 : 4.3 dBi LTE Band 71 : -0.3 dBi n2: 3.4 dBi n5: 1.7 dBi n12: 0.2 dBi n25: 3.4 dBi n41 : 4.5 dBi n66: 4.3 dBi n71 : -0.3 dBi n77 : 3.4 dBi **<For WLAN>** **<Ant. 1>** WLAN 2.4GHz: gain 3.59 dBi WLAN 5.2GHz: gain 4.23 dBi WLAN 5.8GHz: gain 4.92 dBi **<Ant. 2>** WLAN 2.4GHz: gain 3.01 dBi WLAN 5.2GHz: gain 4.60 dBi WLAN 5.8GHz: gain 4.44 dBi
Antenna Type	WWAN : PCB Antenna 5G NR : PCB Antenna WLAN : IFA Antenna
HW Version	Rev1
SW Version	2.52
EUT Stage	Identical Prototype

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. For LTE Band 43 support up to 64QAM, all other LTE bands support up to 256QAM.
3. This device supports HPUE for LTE band 41 with class 2 power level, so HPUE has been performed standalone power density calculation.
4. LTE band 42/43 covered by LTE band 48 with the same power level, so only chose LTE band 48 to perform standalone power density calculation.
5. For DFT-s-OFDM and CP-OFDM output power measurement reduction, according to maximum power reduction for the CP-OFDM mode will not higher than DFT-s-OFDM mode, therefore, CP-OFDM measurement is unnecessary. We always chose higher power (DFT-s-OFDM mode) to perform MPE analysis.
6. 5GNR supports NSA mode.
7. This is a variant report. For model change note, Please refer to the FX2000-3, FX2000e-3_Class II Permissive Change Letter exhibit separately. According to the difference, added 5GNR n77 evaluation based on original report (Sporton Report Number FA082812-04).

Comments and Explanations:
1. The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.
2. The maximum RF output tune up power, antenna gain also the safe distance used for evaluate RF exposure were declared by manufacturer.

3. Maximum RF Tune Up power among production units

<WCDMA>

Mode		Maximum Average power(dBm)
WCDMA	Band II	24.00
	Band IV	24.00
	Band V	24.00

<LTE>

Mode		Maximum Average power(dBm)
LTE	Band 2	24.00
	Band 4	24.00
	Band 5	24.00
	Band 7	24.00
	Band 12	24.00
	Band 13	24.00
	Band 14	24.00
	Band 17	24.00
	Band 25	24.00
	Band 26	24.00
	Band 30	21.00
	Band 38	24.00
	Band 41	24.00
	Band 41-HPUE	26.50
	Band 42	19.50
	Band 43	19.50
	Band 48	19.50
	Band66	24.00
	Band71	24.00

<5G NR>

Mode		Maximum Average power(dBm)
5G NR	n2	24.00
	n5	24.00
	n12	24.00
	n25	24.00
	n41	24.00
	n66	24.00
	n71	24.00
	n77	24.00

<2.4GHz WLAN >

Mode		Maximum Average Power (dBm)		
		ANT1	ANT2	ANT1+2
2.4GHz	802.11b	16.50	16.50	19.50
	802.11g	14.00	14.00	17.00
	802.11n-HT20	14.00	14.00	17.00
	802.11n-HT40	14.00	14.00	17.00
	802.11ax-HE20	14.00	14.00	17.00
	802.11ax-HE40	14.00	14.00	17.00

<5GHz WLAN >

Mode		Maximum Average Power (dBm)		
		ANT1	ANT2	ANT1+2
5.2GHz	802.11a	11.50	11.50	14.50
	802.11n-HT20	11.50	11.50	14.50
	802.11n-HT40	14.50	14.50	17.50
	802.11ac-VHT20	11.50	11.50	14.50
	802.11ac-VHT40	14.50	14.50	17.50
	802.11ac-VHT80	15.00	15.00	18.00
	802.11ax-HE20	11.50	11.50	14.50
	802.11ax-HE40	14.50	14.50	17.50
	802.11ax-HE80	15.00	15.00	18.00
5.8GHz	802.11a	14.00	14.00	17.00
	802.11n-HT20	14.00	14.00	17.00
	802.11n-HT40	14.00	14.00	17.00
	802.11ac-VHT20	14.00	14.00	17.00
	802.11ac-VHT40	14.00	14.00	17.00
	802.11ac-VHT80	14.00	14.00	17.00
	802.11ax-HE20	14.00	14.00	17.00
	802.11ax-HE40	14.00	14.00	17.00
	802.11ax-HE80	14.00	14.00	17.00

Note:
1. WLAN2.4GHz/WLAN5GHz all support SISO/MIMO mode, we only chose MIMO tune up power to perform MPE calculation conservatively for MIMO power is higher.

4. RF Exposure Limit Introduction

According to ANSI/IEEE C95.1-1992, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1310.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f2)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f2)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

The MPE was calculated at **20 cm** to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

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

Where:
S = Power Density
P = Output Power at Antenna Terminals
G = Gain of Transmit Antenna (linear gain)
R = Distance from Transmitting Antenna

5. Radio Frequency Radiation Exposure Evaluation

5.1. Standalone Power Density Calculation

Band	Frequency (MHz)	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	Maximum EIRP (W)	Average EIRP (mW)	Power Density at 20cm (mW/cm^2)	Limit (mW/cm^2)	Power Density / Limit
WCDMA Band 2	1852.4	3.40	24.00	27.400	0.550	549.541	0.109	1.000	0.109
WCDMA Band 4	1712.4	3.80	24.00	27.800	0.603	602.560	0.120	1.000	0.120
WCDMA Band 5	826.4	1.70	24.00	25.700	0.372	371.535	0.074	0.551	0.134
LTE Band 2	1850.7	3.40	24.00	27.400	0.550	549.541	0.109	1.000	0.109
LTE Band 4	1710.7	3.80	24.00	27.800	0.603	602.560	0.120	1.000	0.120
LTE Band 5	824.7	1.70	24.00	25.700	0.372	371.535	0.074	0.550	0.135
LTE Band 7	2502.5	4.60	24.00	28.600	0.724	724.436	0.144	1.000	0.144
LTE Band 12	699.7	0.20	24.00	24.200	0.263	263.027	0.052	0.466	0.112
LTE Band 13	779.5	1.30	24.00	25.300	0.339	338.844	0.067	0.520	0.130
LTE Band 14	790.5	1.70	24.00	25.700	0.372	371.535	0.074	0.527	0.140
LTE Band 17	706.5	0.20	24.00	24.200	0.263	263.027	0.052	0.471	0.111
LTE Band 25	1850.7	3.40	24.00	27.400	0.550	549.541	0.109	1.000	0.109
LTE Band 26	814.7	1.70	24.00	25.700	0.372	371.535	0.074	0.543	0.136
LTE Band 30	2307.5	2.80	21.00	23.800	0.240	239.883	0.048	1.000	0.048
LTE Band 38	2572.5	4.30	24.00	28.300	0.676	676.083	0.135	1.000	0.135
LTE Band 41-HPUE	2498.5	4.50	26.50	31.000	1.259	1258.925	0.251	1.000	**0.251**
LTE Band 48	3552.5	3.60	19.50	23.100	0.204	204.174	0.041	1.000	0.041
LTE Band 66	1710.7	4.30	24.00	28.300	0.676	676.083	0.135	1.000	0.135
LTE Band 71	665.5	-0.30	24.00	23.700	0.234	234.423	0.047	0.444	0.105
5G NR n2	1850	3.40	24.00	27.400	0.550	549.541	0.109	1.000	0.109
5G NR n5	824	1.70	24.00	25.700	0.372	371.535	0.074	0.549	0.135
5G NR n12	699	0.20	24.00	24.200	0.263	263.027	0.052	0.466	0.112
5G NR n25	1850	3.40	24.00	27.400	0.550	549.541	0.109	1.000	0.109
5G NR n41	2496	4.50	24.00	28.500	0.708	707.946	0.141	1.000	**0.141**
5G NR n66	1710	4.30	24.00	28.300	0.676	676.083	0.135	1.000	0.135
5G NR n71	663	-0.30	24.00	23.700	0.234	234.423	0.047	0.442	0.106
5G NR n77	3700	3.40	24.00	27.400	0.550	549.541	0.109	1.000	0.109
2.4GHz WLAN	2412.0	3.59	19.50	23.450	0.221	221.309	0.044	1.000	**0.044**
5.2GHz WLAN	5180.0	4.60	18.00	22.600	0.182	181.970	0.036	1.000	**0.036**
5.8GHz WLAN	5745.0	4.92	17.00	21.920	0.156	155.597	0.031	1.000	0.031

Note:

1. For conservativeness, the lowest frequency of each band is used to determine the MPE limit of that band.
2. This device supports HPUE for LTE band 41 with class 2 power level, so HPUE has been performed standalone power density calculation.
3. LTE band 42/43 covered by LTE band 48 with the same power level, so only chose LTE band 48 to perform standalone power density calculation.
4. Chose the maximum power density to do MPE analysis.

5.2. Collocated Power Density Calculation

WWAN Power Density / Limit	5GNR Power Density / Limit	WLAN 2.4GHz Power Density / Limit	Σ(Power Density / Limit) of WWAN + 5GNR + WLAN 2.4GHz
0.251	0.141	0.044	0.436
WWAN Power Density / Limit	**5GNR Power Density / Limit**	**WLAN 5GHzPower Density / Limit**	**Σ(Power Density / Limit) of WWAN + 5GNR + WLAN 5GHz**
0.251	0.141	0.036	0.428

Note:

1. For colocation analysis, LTE Band41-HPUE is chosen for summation due to the highest (power density/limit) among all WWAN wireless modes.
2. For colocation analysis, 5GNR n41 is chosen for summation due to the highest (power density/limit) among all 5GNR modes.
3. Chose the worst power density among WLAN2.4/5GHz to do co-located.
4. Σ(Power Density / Limit): This is a summation of [(power density for each transmitter/antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for WWAN + 5GNR + WLAN.
5. Considering the WWAN and 5GNR module collocation with the WLAN transmitter of the EIRP performance listed in the table above, the aggregated (power density /limit) is smaller than 1.

Conclusion:

According to 47 CFR §2.1091, the RF exposure analysis concludes that the RF Exposure is FCC compliant.

------THE END------