

Date: September 28, 2020

RF exposure evaluation

Related to product:

Type of equipment:	LTE IoT device embedding a Cat-M B4/13 modem with antenna + a GPS chipset with antenna + a Bluetooth Low Energy antenna
Brand name:	Sequans
Product Marketing Name	Monarch Go-GPS BLE
Model/HVIN:	Monarch Go-GPS BLE
FCC ID:	2AAGMGMQGOB
IC:	12732A-GMQGOB

To whom it may concern,

This is the RF exposure evaluation for this host device to be used in mobile conditions.

According to the tune-up information provided and the values declared of the antenna gain, the following calculations demonstrate that the power density from the product under certification is below the Maximum Permissible Exposure limit under both the FCC and ISED rules.

FCC rules

2.1 Limits for Maximum Permissible Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (minutes)
Limits For General Population / Uncontrolled Exposure				
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f ²)*	30
30-300	27.5	0.073	0.2	30
300-1500	f/1500	30
1500-100,000	1.0	30

f = Frequency in MHz ; *Plane-wave equivalent power density

2.2 MPE Calculation Formula

$$Pd = (Pout \cdot G) / (4 \cdot \pi \cdot r^2)$$

where

Pd = power density in mW/cm²

Pout = output power to antenna in mW

G = gain of antenna in linear scale

pi = 3.1416

r = distance between observation point and center of the radiator in cm

ISED rules

2.1 Limits For Maximum Permissible Exposure (MPE)

Per RSS-102 issue 5, section 2.5.2 as reproduced below:

2.5.2 Exemption from Routine Evaluation Limits – RF Exposure Evaluation

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:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $22.48/f^{0.5}W$ (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- 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;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Frequency Range (MHz)	Electric Field Strength (V/m rms)	Magnetic Field Strength (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
Limits For General Population / Uncontrolled Exposure				
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
 *Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

2.2 MPE CALCULATION FORMULA

$$Pd = (Pout * G) / (4 * pi * r^2)$$

where

Pd = power density in W/m²

Pout = output power to antenna in W

G = gain of antenna in linear scale

pi = 3.1416

r = distance between observation point and center of the radiator in m

Evaluation

Frequency band	Max power (according to Tune-up and including tolerance)	Declared Antenna gain	Limit Distance	Power density	FCC limit	ISED limit	Verdict
LTE 4 1710-1755	25 dBm	0 dBi	20 cm	0.063 mW/cm ² <-> 0.63 W/m ²	1 mW/cm ²	4.24 W/m ²	PASS
LTE 13 777-787	25 dBm	0 dBi	20 cm	0.063 mW/cm ² <-> 0.63 W/m ²	0.52 mW/cm ²	2.47 W/m ²	PASS
Bluetooth LE	4.4 dBm According to test report 64759RRF.001	1 dBi	20 cm	0.00069mW/cm ² <-> 0.0069 W/m ²	1 mW/cm ²	5.35 W/m ²	PASS

LTE and Bluetooth LE can work simultaneously but only one of the LTE bands at a time.

Multiple frequencies assessment

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure at a fixed location. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^n \frac{S_i}{MPE_i} < 1$$

Where

S_i is the power density of each source;

MPE_i is the power density basic restriction of each source.

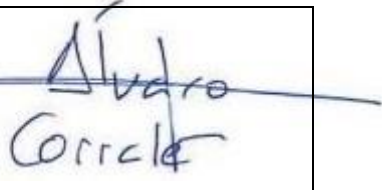
This Product is able to transmit simultaneously using LTE (band 4 or band 13) and Bluetooth LE.

The multiple frequencies calculation will be as follow:

$$0.063 / 1.0 + 0.00069 / 5.35 < 1 \text{ Limit}$$

$$0,06313 \rightarrow < 1 \text{ Limit}$$

Sincerely,

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