

G7 EXO Radio Frequency (RF) Exposure Compliance

1 Document Revision History

Revision	Date	Author	Summary
1	Sep 22, 2020	Scott Jacobsen	Initial release
2	Sep 24, 2020	Scott Jacobsen	Removed antenna details, creating a separate document for that information

2 Purpose of this Report

The purpose of this report is to show the radio frequency (RF) exposure compliance of certain simultaneous transmission configurations of the modules inside the product named G7EXO.

3 Identifiers

3.1 Host Product

Internal Product Name: G7 EXO

Model: G7EXO-NA

3.2 Radio Identifiers

Radio Description	Model	FCC ID	IC ID	Grantee
Cellular	LARA-R202	XPY1EIQ24NN	8595A-1EIQ24NN	u-blox AG
Satellite	9603N	Q639603N	4629A-9603N	Iridium Satellite LLC
Bluetooth	G7EXO-NA2	W77EXO	8255A-EXO	Blackline Safety

3.3 Antennas

Technology	Vendor	Model	Peak Gain(dBi)	Data Sheet Reference
Cellular	Blackline Safety	103452r2	1.0	G7EXO-NA2 Antennas.pdf
Satellite	Taoglas	IP.1621.25.4.A.02	3.0	G7EXO-NA2 Antennas.pdf
Bluetooth	Pulse Electronics	W3008C	2.4	G7EXO-NA2 Antennas.pdf

4 Test Standards

Test Standard	Version	Test Standard Description
FCC 47 CFR 2.1091	e-CFR April 1, 2020	Radiofrequency radiation exposure evaluation: mobile devices.
FCC 47 CFR 1.1310	e-CFR April 1, 2020	Radiofrequency radiation exposure limits
RSS-102	Issue 5, March 2015	5 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

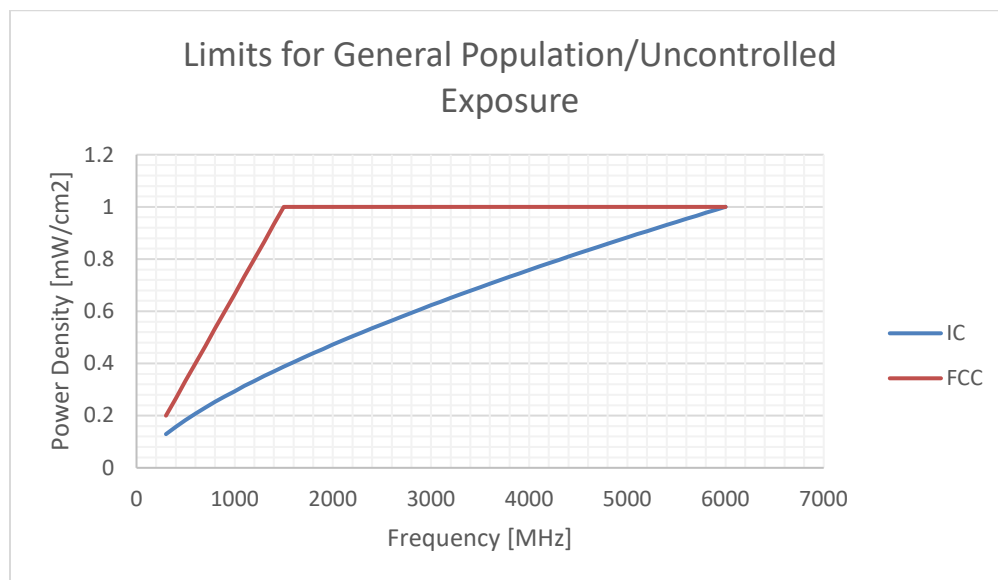
6 Limits

6.1 FCC Limits for General Population/Uncontrolled Exposure

Frequency Range	E-field strength (V/m)	H-field strength (A/m)	B-field strength (μT)	Power density (mW/cm ²)
300 – 1500 MHz	--	--	--	$f(\text{MHz}) / 1500$
1.5 – 100 GHz	--	--	--	1.0

6.2 IC Limits for General Population/Uncontrolled Exposure

Frequency Range	E-field strength (V/m)	H-field strength (A/m)	B-field strength (μT)	Power density (W/m ²)	Power density (mW/cm ²)
300 – 6000 MHz	--	--	--	$0.02619f^{0.6834}$	$0.002619f^{0.6834}$

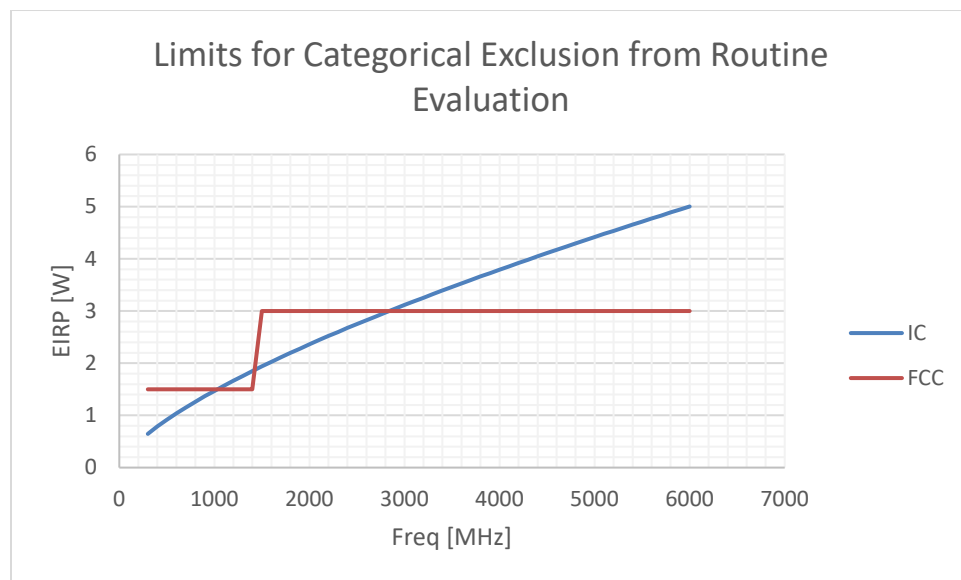


6.3 FCC Limits for Categorical Exclusion from Routine Evaluation

Frequency Range	Specification
Below 1.5 GHz	EIRP < 1.5 W
Above 1.5 GHz	EIRP < 3 W

6.4 IC Limits for Categorical Exclusion from Routine Evaluation

Frequency Range	Specification
300 MHz – below 6 GHz	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



7 RF Exposure Assessment

7.1 Maximum permissible exposure (MPE)

Fixed/mobile exposure conditions of multiple transmitters installed in different hosts represent the most difficult situation in terms of the determination of minimum safety distances. While EMF measurements most often only refer to a single configuration with only one transmitter or with multiple co-located transmitters a general approach is needed to determine a worst case condition under which several transmitters and their antennas can be installed to prevent additional RF exposure evaluation for each host.

This test report illustrates how three specific radio modules can be integrated in a host without the need of further testing.

The background of the calculation is a minimum distance of 20 cm between antenna(s) and user (mobile exposure condition), and the compliance with the requirements of section 5.

7.2 Formulas

1. Average power density for each transmitter at a distance of 20 cm, S_{eq} , is calculated using the following formula:

$$S_{eq} = \frac{P \cdot G}{4\pi \cdot r^2} \times \eta$$

where

P is the peak power conducted into the antenna

G is the peak antenna gain

η is the duty cycle of transmissions

R = 20 cm

2. Then the ratio S_{eq}/S_{lim} is calculated for all applied limits, where S_{lim} is the limit at the frequency of interest, as specified in section 6. This essentially converts the power densities into unit-less values representing the portion of the power density limit generated by individual transmitters.
3. Finally, it must be ensured that the sum of all worst case power densities of all active transmitters do not exceed the limits, even if they are far below the limits for the single transmitter. The ratios for all the transmitters calculated in step 2 are summed together in all possible combinations of transmitters such that

$$\sum_{1}^n \frac{S_{eq\ n}}{S_{lim\ n}} = \frac{S_{eq\ 1}}{S_{lim\ 1}} + \frac{S_{eq\ 2}}{S_{lim\ 2}} + \dots + \frac{S_{eq\ n}}{S_{lim\ n}} \leq 1$$

7.3 Individual Radiated Power Densities

Module	Frequency (MHz)	Conducted Output Power (mW)	Conducted Output Power (dBm)	Antenna Gain (dBi)	Antenna Gain (linear)	EIRP (dBm)	EIRP (mW)	Duty Cycle (%)	S_{eq} - Average Power Density (mW/cm ²)	FCC S_{lim} - Power Density Limit (mW/cm ²)	IC S_{lim} - Power Density Limit (mW/cm ²)	Portion of FCC Limit	Portion of IC Limit
LTE Band 12	711	206.5	23.1	-6.4	0.23	16.7	47	100	0.01	0.47	0.23	0.0199	0.0404
LTE Band 4	1747.5	234.4	23.7	-0.8	0.83	22.9	195	100.00	0.04	1.00	0.43	0.0388	0.0901
LTE Band 2	1905	222.3	23.5	-1.8	0.66	21.7	147	100.00	0.03	1.00	0.46	0.0292	0.0640
LTE Band 5	846.5	199.5	23.0	-1.7	0.68	21.3	135	100.00	0.03	0.56	0.26	0.0475	0.1023
WCDMA 850	846.6	228.0	23.6	-1.7	0.68	21.9	154	100.00	0.03	0.56	0.26	0.0543	0.1169
WCDMA 1900	1907.6	267.0	24.3	-1.8	0.66	22.5	176	100.00	0.04	1.00	0.46	0.0351	0.0768
Satellite	1616	1410.0	31.5	3	2.00	34.5	2813	10.36	0.06	1.00	0.41	0.0580	0.1421
Bluetooth	2441	10.4	10.2	2.2	1.66	12.4	17	100.00	0.00	1.00	0.54	0.0034	0.0063

7.4 Total Radiated Power Densities from Transmitter Combinations – Against FCC Limits

- A. Bluetooth, LTE Band 12, Satellite

$$0.0034 + 0.0199 + 0.0580 = \mathbf{0.0813}$$

- B. Bluetooth, LTE Band 4, Satellite

$$0.0034 + 0.0388 + 0.0580 = \mathbf{0.1002}$$

- C. Bluetooth, LTE Band 2, Satellite

$$0.0034 + 0.0292 + 0.0580 = \mathbf{0.0906}$$

- D. Bluetooth, LTE Band 5, Satellite

$$0.0034 + 0.0475 + 0.0580 = \mathbf{0.1090}$$

- E. Bluetooth, WCDMA 850, Satellite

$$0.0034 + 0.0543 + 0.0580 = \mathbf{0.1158}$$

- F. Bluetooth, WCDMA 1900, Satellite

$$0.0034 + 0.0351 + 0.0580 = \mathbf{0.0965}$$

The summations of the individual radiated power density portions for the transmitter combinations are both less than the limits, and hence the total radiated power density from the G7 EXO is deemed to be compliant with the regulatory requirements.

7.5 Total Radiated Power Densities from Transmitter Combinations – Against IC Limits

- A. Bluetooth, LTE Band 12, Satellite

$$0.0063 + 0.0404 + 0.1421 = \mathbf{0.1888}$$

- B. Bluetooth, LTE Band 4, Satellite

$$0.0063 + 0.0901 + 0.1421 = \mathbf{0.2385}$$

- C. Bluetooth, LTE Band 2, Satellite

$$0.0063 + 0.0640 + 0.1421 = \mathbf{0.2124}$$

- D. Bluetooth, LTE Band 5, Satellite

$$0.0063 + 0.1023 + 0.1421 = \mathbf{0.2507}$$

- E. Bluetooth, WCDMA 850, Satellite

$$0.0063 + 0.1169 + 0.1421 = \mathbf{0.2653}$$

- F. Bluetooth, WCDMA 1900, Satellite

$$0.0063 + 0.0768 + 0.1421 = \mathbf{0.2252}$$

The summations of the individual radiated power density portions for the transmitter combinations are both less than the limits, and hence the total radiated power density from the G7 EXO is deemed to be compliant with the regulatory requirements.

8 Statement of Compliance

The electromagnetic field (EMF) values found for the co-located modules of G7 EXO are below the maximum allowed levels according to the standards listed in section 5 when used with the antennas specified in section 3.3.