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G7 Bridge Model 103989 Radio Frequency (RF) Exposure Compliance

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1 Document Revision History

Revision	Date	Author	Summary
1	June 7, 2021	Scott Jacobsen	Initial release

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 G7 Bridge Model 103989.

3 Identifiers

3.1 Host Product

Internal Product Name: G7 Bridge
Model: 103989

3.2 Radio Identifiers Configuration A

Radio Description	Model	FCC ID	IC ID	Grantee
Cellular	LARA-R202	XPY1EIQ24NN	8595A-1EIQ24NN	u-blox AG
Satellite	9602N	Q639603N	4629A-9603N	Iridium Satellite LLC
Frequency Hopping Transceiver	MLINK G 900A FW	KQNMLINK900	2361A-MLINK900	Murandi Communications Ltd

3.3 Radio Identifiers Configuration B

Radio Description	Model	FCC ID	IC ID	Grantee
Cellular	LARA-R202	XPY1EIQ24NN	8595A-1EIQ24NN	u-blox AG
Satellite	9602N	Q639603N	4629A-9603N	Iridium Satellite LLC
Frequency Hopping Transceiver	AMU900	2AZEH-AMU900	27118-AMU900	Aurora Wireless Networks Inc.

3.4 Antennas

Frequency Band	Vendor	Model	Peak Gain(dBi)	Data Sheet Reference
Cellular	Blackline Safety	102214r1	-0.5	G7 Bridge Antennas.pdf
Satellite	Taoglas	IP.1621.25.4.A.02	3.0	G7 Bridge Antennas.pdf
915 MHz ISM	Murandi Communications	MLink Antenna	2.4	G7 Bridge 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)

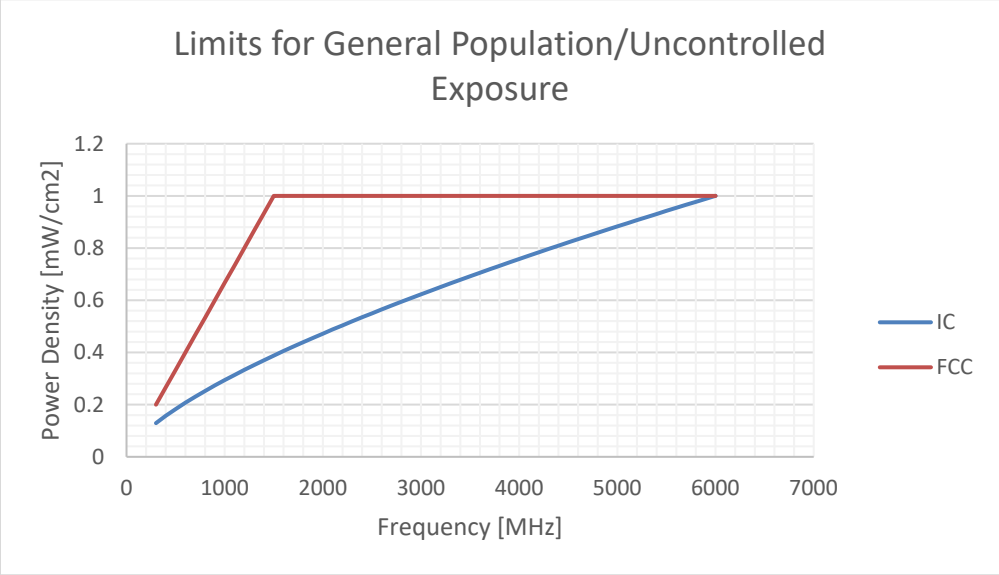
6 Limits

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/cm2)
300 – 1500 MHz	--	--	--	f(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/m2)	Power density (mW/cm2)
300 – 6000 MHz	--	--	--	$0.02619f^{0.6834}$	$0.002619f^{0.6834}$

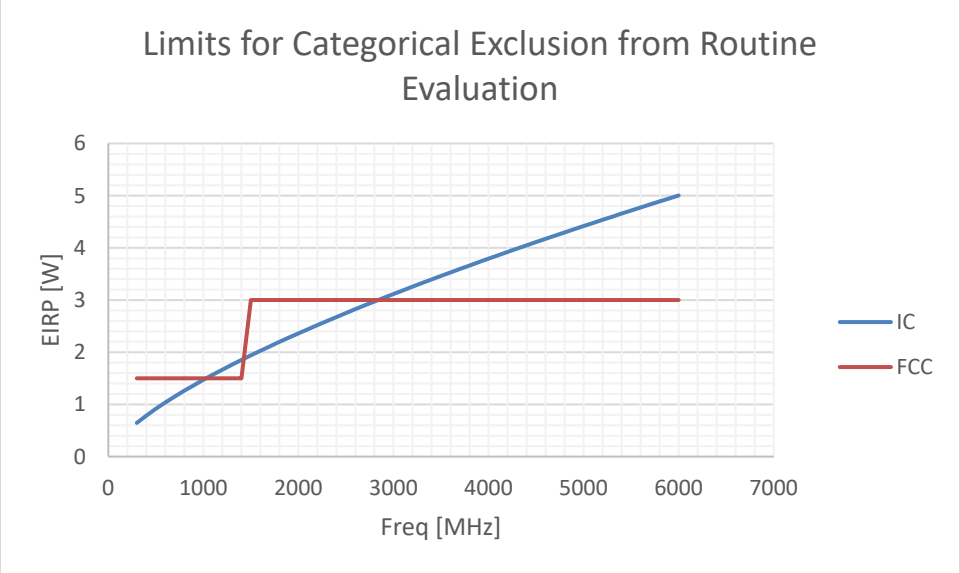


6.3 FCC Limits for Categorical Exclusion from Routine Evaluation

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

ɳ 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

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

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	-3.3	0.47	19.8	97	100	0.02	0.47	0.23	0.0405	0.0825
LTE Band 4	1747.5	234.4	23.7	-0.5	0.89	23.2	209	100.00	0.04	1.00	0.43	0.0416	0.0965
LTE Band 2	1905	222.3	23.5	-0.8	0.83	22.7	185	100.00	0.04	1.00	0.46	0.0368	0.0805
LTE Band 5	846.5	199.5	23.0	-2.2	0.60	20.8	120	100.00	0.02	0.56	0.26	0.0424	0.0912
WCDMA 850	846.6	228.0	23.6	-2.2	0.60	21.4	137	100.00	0.03	0.56	0.26	0.0484	0.1042
WCDMA 1900	1907.6	267.0	24.3	-0.8	0.83	23.5	222	100.00	0.04	1.00	0.46	0.0442	0.0967
Satellite	1616	1410.0	31.5	3	2.00	34.5	2813	10.36	0.06	1.00	0.41	0.0580	0.1421
900 MHz FCC ID KQNMLINK900	903	800	29.0	2.4	1.74	31.4	1390	50.00	0.14	0.60	0.27	0.2297	0.5044
900 MHz FCC ID 2AZEH-AMU900	915	973	29.9	2.4	1.74	32.3	1691	50.00	0.17	0.61	0.28	0.2757	0.6079

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

7.4.1 Configuration A

A. 900 MHz, LTE Band 12, Satellite

   0.2297 + 0.0405 + 0.0580 = **0.3282**

B. 900 MHz, LTE Band 4, Satellite

   0.2297 + 0.0416 + 0.0580 = **0.3293**

C. 900 MHz, LTE Band 2, Satellite

   0.2297 + 0.0368 + 0.0580 = **0.3245**

D. 900 MHz, LTE Band 5, Satellite

   0.2297 + 0.0424 + 0.0580 = **0.3301**

E. 900 MHz, WCDMA 850, Satellite

0.2297 + 0.0484 + 0.0580 = **0.3361**

F. 900 MHz, WCDMA 1900, Satellite

0.2297 + 0.0442 + 0.0580 = **0.3319**

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 Bridge Model 103989 Configuration A is deemed to be compliant with the FCC regulatory requirements.

7.4.2 Configuration B

A. 900 MHz, LTE Band 12, Satellite

0.2757 + 0.0405 + 0.0580 = **0.3743**

B. 900 MHz, LTE Band 4, Satellite

0.2757 + 0.0416 + 0.0580 = **0.3753**

C. 900 MHz, LTE Band 2, Satellite

0. 2757 + 0.0368 + 0.0580 = **0.3705**

D. 900 MHz, LTE Band 5, Satellite

0. 2757 + 0.0424 + 0.0580 = **0.3761**

E. 900 MHz, WCDMA 850, Satellite

0. 2757 + 0.0484 + 0.0580 = **0.3821**

F. 900 MHz, WCDMA 1900, Satellite

0. 2757 + 0.0442 + 0.0580 = **0.3779**

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 Bridge Model 103989 Configuration B is deemed to be compliant with the FCC regulatory requirements.

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

7.5.1 Configuration A

A. 900 MHz, LTE Band 12, Satellite

0.5044 + 0.0825 + 0.1421 = **0.7290**

B. 900 MHz, LTE Band 4, Satellite

0. 5044 + 0.0965 + 0.1421 = **0.7430**

C. 900 MHz, LTE Band 2, Satellite

0. 5044 + 0.0805 + 0.1421 = **0.7270**

D. 900 MHz, LTE Band 5, Satellite

0. 5044 + 0.0912 + 0.1421 = **0.7376**

E. 900 MHz, WCDMA 850, Satellite

0. 5044 + 0.1042 + 0.1421 = **0.7506**

F. 900 MHz, WCDMA 1900, Satellite

0. 5044 + 0.0967 + 0.1421 = **0.7431**

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 Bridge Model 103989 Configuration A is deemed to be compliant with the IC regulatory requirements.

7.5.2 Configuration B

A. 900 MHz, LTE Band 12, Satellite

0.6079 + 0.0825 + 0.1421 = **0.8325**

B. 900 MHz, LTE Band 4, Satellite

0. 6079 + 0.0965 + 0.1421 = **0.8465**

C. 900 MHz, LTE Band 2, Satellite

0. 6079 + 0.0805 + 0.1421 = **0.8305**

D. 900 MHz, LTE Band 5, Satellite

   0. 6079 + 0.0912 + 0.1421 = **0.8412**

E. 900 MHz, WCDMA 850, Satellite

   0. 6079 + 0.1042 + 0.1421 = **0.8542**

F. 900 MHz, WCDMA 1900, Satellite

   0. 6079 + 0.0967 + 0.1421 = **0.8466**

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 Bridge Model 103989 Configuration B is deemed to be compliant with the IC regulatory requirements.

8 Statement of Compliance

The electromagnetic field (EMF) values found for the co-located modules of G7 Bridge Model 103989 are below the maximum allowed levels according to the standards listed in section 5 when used with the antennas specified in section 3.3.