

Test report No:
NIE: 77195RAN.001

Assessment report RF EXPOSURE REPORT ACCORDING TO FCC 47 CFR Part 2.1091

(*) Identification of item under evaluation	Cat1 bis data only module
(*) Trademark	u-blox
(*) Model and /or type reference	LEXI-R10401D
(*) Other identification of the product	HW version: UBX-437C01 SW Version: 01.00.A00.03 IMEI TAC: 35831453, 35755524 FCC ID: XPYUBX23AD01 IC ID: 8595A-UBX23AD01
(*) Features	LTE Cat1 bis, Wi-fi Scan / Locate
(*) Manufacturer	u-blox AG Zürcherstrasse 68, CH-8800 Thalwil, Switzerland
Test method requested, standard	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager
Date of issue	2024-04-02
Report template No	FAN36_01 (*) "Data provided by the client"

Index

Competences and guarantees	3
General conditions	3
Data provided by the client.....	3
Identification of the client.....	3
Document history	3
Appendix A: FCC RF Exposure assessment result	4
General description of the equipment under evaluation	5
Maximum Antenna Gain determination for RF Exposure compliance	5
Appendix B: FCC RF Exposure information	7
FCC RF Exposure evaluation	8
FCC MPE Evaluation.....	9
FCC Cellular bands limits	9

Competences and guarantees

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification, S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification, S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification, S.A.U. at the time of performance of the test.

DEKRA Testing and Certification, S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Assessment Report apply only to the particular item under test established in this document.

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA Testing and Certification, S.A.U.

General conditions

1. This report is only referred to the item that has undergone the assessment.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification, S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification, S.A.U. and the Accreditation Bodies

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item under evaluation", "Trademark", "Model and/or type reference", "General description of the device", "Other identification of the product").
2. Request for evaluation under mobile exposure conditions.
3. The device under evaluation consists of a Cat1 bis data only module for industrial IoT applications.

DEKRA Testing and Certification, S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Identification of the client

Company name: u-blox AG

Postal address: Zürcherstrasse 68, CH-8800 Thalwil, Switzerland

Contact person: Giulio Comar

Telephone / e-mail: +39 040 2603 757 / giulio.comar@u-blox.com

Document history

Report number	Date	Description
77195RAN.001	2024-04-02	First release

Appendix A: FCC RF Exposure assessment result

General description of the equipment under evaluation

Table 1 shows information used for the RF Evaluation, taking into account the following declared specifications for the device:

Description and technologies: the device under evaluation consists of a module with the following features: LTE Cat1 bis, Wi-fi Scan / Locate. For RF Exposure evaluation, only transmission technology: LTE Cat1 bis is taken into account.

Evaluation Distance: a conservative evaluation distance of 20 cm has been used to perform the assessment.

Maximum output power:

- Values corresponding to conducted output power have been measured and stated into DEKRA Testing and Certification, S.A.U. test reports num. 77195RRF001, 77195RRF002, 77195RRF003 and 77195RRF004.

The following table shows the information provided above:

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Maximum Conducted Output Power (dBm)
LTE	2	1850 - 1910	23.17
LTE	5	824 - 849	23.48
LTE	12	699 - 716	24.07
LTE	13	777 - 787	23.84
LTE	14	788 - 798	23.48
LTE	66	1710 - 1780	23.41
LTE	71	663 - 698	23.78

Table 1: Equipment specifications

Maximum Antenna Gain determination for RF Exposure compliance

Summary of maximum antenna gain values:

Maximum antenna gain for mobile operation to comply with MPE and EIRP limits (see Appendix B) shall not exceed the following values:

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Max Gain to comply with RF Exp Limits (dBi)	Max Gain to comply with EIRP Limits (dBi)	Maximum allowed Gain (worst case) (dBi)
LTE	2	1850 - 1910	13.84	9.83	9.83
LTE	5	824 - 849	10.93	17.12	10.93
LTE	12	699 - 716	9.63	12.85	9.63
LTE	13	777 - 787	10.32	13.08	10.32
LTE	14	788 - 798	10.74	13.44	10.74
LTE	66	1710 - 1780	13.60	6.59	6.59
LTE	71	663 - 698	9.69	13.14	9.69

Table 2: Maximum Antenna Gain values

Maximum Gain to meet FCC Radiofrequency radiation exposure limits:

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Distance (cm)	Power density for Gain = 0 dBi (mW/cm ²)	FCC General Population Limit (mW/cm ²)	Maximum Gain to comply with RF Exposure Limits (dBi)
LTE	2	1850 - 1910	20.00	0.04	1.00	13.84
LTE	5	824 - 849	20.00	0.04	0.55	10.93
LTE	12	699 - 716	20.00	0.05	0.47	9.63
LTE	13	777 - 787	20.00	0.05	0.52	10.32
LTE	14	788 - 798	20.00	0.04	0.53	10.74
LTE	66	1710 - 1780	20.00	0.04	1.00	13.60
LTE	71	663 - 698	20.00	0.05	0.44	9.69

Table 3: Maximum Antenna Gain values based on FCC MPE limits

Maximum Gain to meet FCC EIRP limits

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Maximum Output power (dBm)	EIRP Limits (dBm)	Maximum Gain to meet EIRP Limits (dBi)
LTE	2	1850 - 1910	23.17	33.00	9.83
LTE	5	824 - 849	23.48	40.60	17.12
LTE	12	699 - 716	24.07	36.92	12.85
LTE	13	777 - 787	23.84	36.92	13.08
LTE	14	788 - 798	23.48	36.92	13.44
LTE	66	1710 - 1780	23.41	30.00	6.59
LTE	71	663 - 698	23.78	36.92	13.14

Table 4: Maximum Antenna Gain values based on FCC EIRP limits

Appendix B: FCC RF Exposure information

FCC RF Exposure evaluation

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be at least 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

TABLE 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)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*100	6
3.0–30	1842/f	4.89/f	*900/f ²	6
30–300	61.4	0.163	1.0	6
300–1,500			f/300	6
1,500–100,000			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/f ²	30
30–300	27.5	0.073	0.2	30
300–1,500			f/1500	30
1,500–100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

FCC MPE Evaluation

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst-case" or conservative prediction:

$$\text{Power density: } S[mW / cm^2] = \frac{P_{\max}[mW]}{4\pi R[cm]^2}$$

$$\text{Maximum gain to meet the MPE limit: } G_{\max}[dBi] = (10 * \log[S[mW / cm^2]] * 4\pi R[cm]^2) - P_{\max}[dBm]$$

S = power density

P_{\max} = power input to the antenna

R = distance to the center of radiation of the antenna (evaluation distance)

G_{\max} = power gain of the antenna in the direction of interest relative to an isotropic radiator

FCC Cellular bands limits

Maximum FCC EIRP limits are frequency-dependent and are stated into the FCC standards shown in the following table:

Standard	Frequency Band (MHz)	EIRP limit (W)	EIRP limit (dBm)
FCC 47 CFR §27.50 (c)	600-746	4.92	36.92
FCC 47 CFR §27.50 (b)	776-787	4.92	36.92
FCC Clause 90.542 (a) (7)	788-798	4.92	36.92
FCC 47 CFR §22.913	814-849	11.48	40.6
FCC 47 CFR §27.50 (d)	1710-1780	1.0	30.0
FCC 47 CFR §24.232	1850-1915	2.0	33.0
FCC 47 CFR §27.50 (a)	2305-2315	0.25 (average EIRP)	23.9
FCC 47 CFR §27.50 (h) (2)	2496-2690	2.0	33.0
FCC 47 CFR §96.41 (b)	3550-3700	0.2	23
FCC 47 CFR §27.5 (j)	3700-3980	1	30