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Test report No:

NIE: 80874RAN.004

Assessment report
RF EXPOSURE REPORT ACCORDING TO
FCC 47 CFR Part 2.1091; FCC 47 CFR Part 1.1310
FCC 47 CFR Part 2.1093; FCC 47 CFR Part 1.1307

(*) Identification of item under evaluation	LTE Cat 1 bis data module
(*) Trademark	u-blox
(*) Model and /or type reference	LEXI-R10011D
(*) Other identification of the product	FCC ID : XPYUBX24AD02 IC ID : 8595A-UBX24AD02 HW version : UBX-463AD0 SW Version : 01.07.A01.00
(*) Features	LTE Cat1 bis, Wi-fi Scan / Locate
(*) Manufacturer	u-blox AG Zurcherstrasse 68, CH-8800 Thalwil, Switzerland
Test method requested, standard	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. FCC 47 CFR Part 2.1093. Radiofrequency radiation exposure evaluation: portable devices. FCC 47 CFR Part 1.1307: Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared. FCC 47 CFR Part 1.1310: Radiofrequency radiation exposure limits.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Manuel García Antennas Lab Technical Responsible
Date of issue	2025-04-01
Report template No	FAN36_01 (*) "Data provided by the client"

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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. Maximum output power, maximum antenna gain and use distance information.

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

u-blox AG

Zurcherstrasse 68, CH-8800 Thalwil, Switzerland

Document history

Report number	Date	Description
80874RAN.004	2025-04-01	First release

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Appendix A: FCC RF Exposure assessment result

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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: To evaluate the maximum antenna gain, a conservative evaluation distance of 20 cm has been used to perform the assessment. To perform the RF exposure assessment results, the minimum separation distance between the radiating structures of the device and nearby users will be greater than 6 cm. In order to perform the assessment a conservative evaluation distance of 6 cm have been used.

Maximum output power:

- Values corresponding to maximum output power have been declared by the device manufacturer. These values are stated in module manufacturer´s datasheet.

Antennas: the device supports one antenna for the following transmission technology:

- "TAOGLASS Phoenix II" antenna, for LTE Cat1 bis.

The manufacturer has declared the maximum peak gain values, as stated in the antenna manufacturer's datasheet.

The following table shows the information provided above:

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Maximum Conducted Output Power (Incl. Tune-Up) (dBm)	Antenna peak gain (dBi)	Maximum E.R.P. (dBm)	Maximum E.R.P. (mW)	Maximum E.I.R.P. (dBm)	Maximum E.I.R.P. (mW)
LTE	2	1850 - 1910	24.00	2.90	24.75	298.54	26.90	489.78
LTE	4	1710 - 1755	24.00	2.90	24.75	298.54	26.90	489.78
LTE	5	824 - 849	24.00	1.20	23.05	201.84	25.20	331.13
LTE	7	2500 - 2570	24.00	2.10	23.95	248.31	26.10	407.38
LTE	8	897.5 - 900.5	24.00	1.20	23.05	201.84	25.20	331.13
LTE	12	699 - 716	24.00	1.70	23.55	226.46	25.70	371.54
LTE	13	777 - 787	24.00	1.70	23.55	226.46	25.70	371.54
LTE	25	1850 - 1915	24.00	2.90	24.75	298.54	26.90	489.78
LTE	38	2570 - 2620	24.00	2.10	23.95	248.31	26.10	407.38
LTE	41	2496 - 2690	24.00	2.10	23.95	248.31	26.10	407.38
LTE	66	1710 - 1780	24.00	2.90	24.75	298.54	26.90	489.78

Table 1: Equipment specifications

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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	13.01	9.00	9.00
LTE	4	1710 - 1755	13.01	6.00	6.00
LTE	5	824 - 849	10.41	16.60	10.41
LTE	7	2500 - 2570	13.01	9.00	9.00
LTE	8	897.5 - 900.5	10.78	12.92	10.78
LTE	12	699 - 716	9.70	12.92	9.70
LTE	13	777 - 787	10.16	12.92	10.16
LTE	25	1850 - 1915	13.01	9.00	9.00
LTE	38	2570 - 2620	13.01	9.00	9.00
LTE	41	2496 - 2690	13.01	9.00	9.00
LTE	66	1710 - 1780	13.01	6.00	6.00

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/cm²)	FCC General Population Limit (mW/cm²)	Maximum Gain to comply with RF Exposure Limits (dBi)
LTE	2	1850 - 1910	20.00	0.05	1.00	13.01
LTE	4	1710 - 1755	20.00	0.05	1.00	13.01
LTE	5	824 - 849	20.00	0.05	0.55	10.41
LTE	7	2500 - 2570	20.00	0.05	1.00	13.01
LTE	8	897.5 - 900.5	20.00	0.05	0.60	10.78
LTE	12	699 - 716	20.00	0.05	0.47	9.70
LTE	13	777 - 787	20.00	0.05	0.52	10.16
LTE	25	1850 - 1915	20.00	0.05	1.00	13.01
LTE	38	2570 - 2620	20.00	0.05	1.00	13.01
LTE	41	2496 - 2690	20.00	0.05	1.00	13.01
LTE	66	1710 - 1780	20.00	0.05	1.00	13.01

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

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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	24.00	33.00	9.00
LTE	4	1710 - 1755	24.00	30.00	6.00
LTE	5	824 - 849	24.00	40.60	16.60
LTE	7	2500 - 2570	24.00	33.00	9.00
LTE	8	897.5 - 900.5	24.00	36.92	12.92
LTE	12	699 - 716	24.00	36.92	12.92
LTE	13	777 - 787	24.00	36.92	12.92
LTE	25	1850 - 1915	24.00	33.00	9.00
LTE	38	2570 - 2620	24.00	33.00	9.00
LTE	41	2496 - 2690	24.00	33.00	9.00
LTE	66	1710 - 1780	24.00	30.00	6.00

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

Evaluation Results

Determination of Exemption according to FCC 47 CFR Part 1.1307:

The evaluation according to the minimum intended use distance of 6 cm will be as follow:

RF Exposure __Exemption__ evaluation:

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Distance (cm)	Maximum Conducted Power (mW)	Maximum E.R.P. (mW)	§1.1307(b)(3).i.(C) Exposure Limit (mW)	§ 1.1307(b)(3).i.(B) Exposure Limit (mW)	Verdict
LTE	2	1850 - 1910	6.00	N/A	298.54	N/A	330.67	Pass
LTE	4	1710 - 1755	6.00	N/A	298.54	N/A	338.07	Pass
LTE	5	824 - 849	6.00	251.19	N/A	N/A	309.54	Pass
LTE	7	2500 - 2570	6.00	251.19	N/A	N/A	305.98	Pass
LTE	8	897.5 - 900.5	6.00	251.19	N/A	N/A	315.30	Pass
LTE	12	699 - 716	6.00	251.19	N/A	32.21	298.75	Pass
LTE	13	777 - 787	6.00	251.19	N/A	35.80	305.65	Pass
LTE	25	1850 - 1915	6.00	N/A	298.54	N/A	330.45	Pass
LTE	38	2570 - 2620	6.00	251.19	N/A	N/A	304.45	Pass
LTE	41	2496 - 2690	6.00	251.19	N/A	N/A	302.35	Pass
LTE	66	1710 - 1780	6.00	N/A	298.54	N/A	336.82	Pass

Table 5: FCC Exemption Evaluation Results

The computed value(s) are below the exemption limit(s), so these modes meet the requirements stated in FCC 47 CFR Part 1.1307.

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Appendix B: FCC RF Exposure information

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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:

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

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 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 (h) (2)	2496-2690	2.0	33.0

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RF Exposure determination of exemption

According to FCC 47 CFR §1.1307 (b)(3) Determination of exemption:

(i) For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2), a single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold Pth (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). Pth is given by:

$$P_{th}\ (mW) = \begin{cases} ERP_{20\ cm}(d/20\ cm)^x & d \leq 20\ cm \\ ERP_{20\ cm} & 20\ cm < d \leq 40\ cm \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\ cm}\ (mW) = \begin{cases} 2040f & 0.3\ GHz \leq f < 1.5\ GHz \\ 3060 & 1.5\ GHz \leq f \leq 6\ GHz \end{cases}$$

d = the separation distance (cm);

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

TABLE 1 TO §1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 $R^2 f$.
1,500-100,000	19.2R^2.

(ii) For multiple RF sources: Multiple RF sources are exempt if:

(A) The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).

(B) in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for Pth, including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section for Threshold ERP, including existing exempt transmitters and those being added.

c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.

P_i = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).

$P_{th,i}$ = the exemption threshold power (Pth) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i.

ERP_j = the ERP of fixed, mobile, or portable RF source j.

$ERP_{th,j}$ = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least $\lambda/2\pi$ according to the applicable formula of paragraph (b)(3)(i)(C) of this section.

$Evaluated_k$ = the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

$Exposure\ Limit_k$ = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from §1.1310 of this chapter.

The available maximum time-averaged power or effective radiated power (ERP), can be calculated using the following formula to assess compliance with the Exemption Limits:

$P_{E.I.R.P.} = P_T + G_T - L_C$
    Where:
    P_T= transmitter time-averaged output power (including Duty Cycle and tune-up tolerance, if applicable)
    G_T= gain of the transmitting antenna
    L_C = signal attenuation in the connecting cable between the transmitter and the antenna if applicable

$P_{E.R.P.} = P_{E.I.R.P.} - 2.15\ dB$