



RF Exposure Test Report

Report No. : W7L-240614W001SA01

Applicant : U-BLOX AG

Address : ZÜRCHERSTRASSE 68, CH-8800 THALWIL, SWITZERLAND

Product : LTE CAT-M1 / NB-IOT MODULE

FCC ID : XPYUBX23KM02

IC : 8595A-UBX23KM02

Brand : U-BLOX

Model No. : LEXI-R520

Standards : FCC Part 2 (Section 2.1091)
RSS-102 Issue6 / Health Canada's Safety Code 6
KDB 447498 D01 General RF Exposure Guidance v06

Sample Received Date : Jun. 14, 2024

Date of Testing : Jun. 14, 2024 ~ Jun. 17, 2024

Test Lab : The FCC Site Registration No. is 434559; The Designation No. is CN1325.
The IC Company Number is 28371; The CAB Identifier No. is CN0131.

ISSUED BY : Huarui 7layers High Technology (Suzhou) Co., Ltd.

ADDRESS : Tower N, Innovation Center, 88 Zhuyi Road, High-tech District, Suzhou City, Anhui Province China

CERTIFICATION: The above equipment have been tested by **HUARUI 7LAYERS HIGH TECHNOLOGY (SUZHOU) CO., Ltd.** and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by A2LA or any government agencies.

Prepared By : Chang Gao
(Chang Gao/ Engineer)

Approved By : Sampei bo
(Peibo Sun /Manager)

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Release Control Record

Report No.	Reason for Change	Date Issued
W7L-240614W001SA01	Initial release	Jun. 17, 2024



1. Summary

2.1 Technical Report Summary

Type of Report

RF Exposure and Maximum ERP/EIRP Assessment for a CAT-M1/NB-IoT radio module. Including RF Exposure for use with co-located radios on generic host device.

Applicable FCC and ISED Rules

For RF Exposure:

KDB 447498 D01 General RF Exposure Guidance v06
FCC 47 CFR §1.1307
FCC 47 CFR §1.1310
RSS-102 Issue 6

For Maximum ERP/EIRP:

FCC 47 CFR §22.913
ISED RSS-132, Issue 4
FCC 47 CFR §24.232
ISED RSS-133 Issue 6, Amendment 1
FCC 47 CFR §27.50(b), (c), (d)
ISED RSS-139, Issue 4 / SRSP-513, RSS-130, Issue 2, ISED RSS-195, Issue 2, ISED RSS-199, Issue 3
FCC 47 CFR §90.635
ISED RSS-140, Issue 1

Standard	Frequency Band
FCC 47 CFR §22.913 ISED RSS-132, Issue 4	eFDD5/ eFDD26
FCC 47 CFR §24.232 ISED RSS-133 Issue 6, Amendment 1	eFDD2/ eFDD25
FCC 47 CFR §27.50(d) ISED RSS-139, Issue 4 / SRSP-513	eFDD4/66
FCC 47 CFR §27.50(c) ISED RSS-130, Issue 2	eFDD12 / eFDD85 / eFDD71
FCC 47 CFR §27.50(b) ISED RSS-130, Issue 2	eFDD13
FCC 47 CFR §90.635	eFDD26
FCC 47 CFR §27.1507(a)	eFDD8



2. Description of Equipment Under Test

EUT Type*	LTE CAT-M1 / NB-IoT Module
FCC ID*	XPYUBX23KM02
IC*	8595A-UBX23KM02
Brand Name*	u-blox
Model Name*	LEXI-R520
Frequency Bands (Unit: MHz)	CAT-M1/NB-IoT: 1850MHz ~ 1910MHz (FOR LTE Band2) 1710MHz ~ 1755MHz (FOR LTE Band4) 824MHz ~ 849MHz (FOR LTE Band5) 897.5MHz ~ 900.5MHz (FOR LTE Band8A) (FCC only) 699MHz ~ 716MHz (FOR LTE Band12) 777MHz ~ 787MHz (FOR LTE Band13) 1850MHz ~ 1915MHz (FOR LTE Band25) 827MHz ~ 844MHz (FOR LTE Band26 part 22) 814.7MHz ~ 819MHz (FOR LTE Band26 part 90) (FCC only) 1710MHz ~ 1780MHz (FOR LTE Band66) 663MHz ~ 698MHz (FOR LTE Band71) 698MHz ~ 716MHz (FOR LTE Band85)
Modulations*	CAT-M/ NB-IoT: BPSK/QPSK/16QAM
Antenna Type*	See Note 3
EUT Stage*	Production Unit

Note:

- *Since the above data and/or information is provided by the client relevant results or conclusions of this report are only made for these data and/or information , Test Lab is not responsible for the authenticity, integrity and results of the data and information and/or the validity of the conclusion.
- The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.
- EUT is equipped with a temporary antenna connector. The Module is not sold with a predefined antenna.



3. MPE(Maximum Permissible Exposure) Assessment

3.1 Introduction

According to 47 CFR §2.1091, a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 cm is normally maintained between the transmitting antenna and the body of the user or nearby persons. In this context, the term “fixed location” means that the device is physically secured at one location and is not able to be easily moved to another location. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20 cm separation requirement. The limits to be used for MPE evaluation are specified in §1.1310. All unlicensed personal communications service (PCS) devices and unlicensed NII devices shall be subject to the limits for general population/uncontrolled exposure.

3.2 RF Radiation Exposure Limits

FCC

According to 47 CFR §1.1310, the criteria listed in below table shall be used to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093.

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (min)
(A) Limits for Occupational / Controlled Exposures				
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 – 1500	-	-	f/300	6
1500 – 100000	-	-	5	6
(B) Limits for General Population / Uncontrolled Exposures				
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 – 100000	-	-	1.0	30

Limits for maximum permissible exposure (MPE)

Notes:

- f = frequency in MHz
- Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided they are made aware of the potential for exposure.
- General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

IC

The electronic and electro-technical apparatus shall comply with the basic restriction as specified in IC RSS-102.



A summary of the reference levels is given in below table.

Frequency range (MHz)	Electric field (V _{RMS} /m)	Magnetic field (A _{RMS} /m)	Power density (W/m ²)	Reference period (minutes)
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 × 10 ⁻⁴ $f^{0.5}$	6.67 × 10 ⁻⁵ f	616000/ $f^{1.2}$

Note: f is frequency in MHz.

RF field strength and power density limits for devices used by the general public (uncontrolled environment)

Frequency range (MHz)	Electric field (V _{RMS} /m)	Magnetic field (A _{RMS} /m)	Power density (W/m ²)	Reference period (minutes)
10-20	61.4	0.163	10	6
20-48	129.8 / $f^{0.25}$	0.3444 / $f^{0.25}$	44.72 / $f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	15.60 $f^{0.25}$	0.04138 $f^{0.25}$	0.6455 $f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000 / $f^{1.2}$
150000-300000	0.354 $f^{0.5}$	9.40 × 10 ⁻⁴ $f^{0.5}$	3.33 × 10 ⁻⁴ f	616000 / $f^{1.2}$

Note: f is frequency in MHz.

RF field strength and power density limits for controlled-use devices (controlled environment)



3.3 MPE Assessment Method

Calculations can be made to predict RF field strength and power density levels around typical RF sources. For example, in the case of a single radiating antenna, a prediction for power density in the far-field of the antenna can be made by use of the general Equations below. This equation is generally accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction.

$$\text{Power Density (S)} = \frac{PG}{4\pi R^2} = \frac{\text{EIRP}}{4\pi R^2}$$

Where

S = Power Density, unit in mW/cm²

P = Power input to the antenna, unit in mW

G = Power gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna, unit in cm

EIRP = Effective isotropically radiated power

3.4 MPE Calculation for Standalone Operations

The manufacturer expects that the radiated component of this device will not close to the human body during normal usage and the warning statement was also stated in the user instruction. Since the transmitting antenna will be kept at least 20 cm away from the human body, the MPE level is calculated based on this condition and the result is listed in below table.



CALCULATION FOR MAXIMUM E.I.R.P

Band	Mode	Duty Cycle	Frequency Range (MHZ)	Maximum Conducted output power (dBm)	FCC / IC EIRP limit (Watts)	Maximum antenna gain to meet EIRP Limit (dBi)
eFDD 71	CAT M	100.0%	663 - 698	22.94	3 (ERP)	11.8
eFDD 85	CAT M	100.0%	698 -716	22.26	3 (ERP)	12.5
eFDD 2	CAT M	100.0%	1850-1910	22.39	2	10.6
eFDD 4	CAT M	100.0%	1710-1755	22.34	1 (EIRP)	7.7
eFDD 5	CAT M	100.0%	824 - 849	23.18	11.5	17.4
eFDD 12	CAT M	100.0%	699-716	22.68	3 (ERP)	12.1
eFDD 13	CAT M	100.0%	777-787	22.81	3 (ERP)	12.0
eFDD 25	CAT M	100.0%	1850-1915	22.67	2	10.3
eFDD 26 (part 22)	CAT M	100.0%	827-844	23.15	11.5	17.5
eFDD 26 (part 90) (FCC only)	CAT M	100.0%	814.7-819	22.94	1	7.1
eFDD 66	CAT M	100.0%	1710-1780	22.46	1 (EIRP)	7.5
eFDD 8 (FCC only)	CAT M	100.0%	897.5-900.5	22.68	3 (ERP)	12.1

Band	Mode	Duty Cycle	Frequency Range (MHZ)	Maximum Conducted output power (dBm)	FCC / IC EIRP limit (Watts)	Maximum antenna gain to meet EIRP Limit (dBi)
eFDD 71	NB-IOT	100.00%	698-716	22.3	3 (ERP)	12.5
eFDD 85	NB-IOT	100.00%	663 - 698	22.55	3 (ERP)	12.2
eFDD 2	NB-IOT	100.00%	1850-1910	22.62	2	10.4
eFDD 4	NB-IOT	100.00%	1710-1755	22.67	1 (EIRP)	7.3
eFDD 5	NB-IOT	100.00%	824 - 849	22.58	11.5	18.0
eFDD 12	NB-IOT	100.00%	699-716	22.43	3 (ERP)	12.3
eFDD 13	NB-IOT	100.00%	777-787	22.13	3 (ERP)	12.6
eFDD 25	NB-IOT	100.00%	1850-1915	22.61	2	10.4
eFDD 26 (part 22)	NB-IOT	100.00%	827-844	22.62	11.5	18.0
eFDD 26 (part 90) (FCC only)	NB-IOT	100.00%	814.7-819	22.44	1	7.6
eFDD 66	NB-IOT	100.00%	1710-1780	22.76	1 (EIRP)	7.2
eFDD 8 (FCC only)	NB-IOT	100.00%	897.5-900.5	22.36	3 (ERP)	12.4

Conclusion:

Host devices using the gains shown in the above table would meet the EIRP requirements for FCC and Industry Canada. Note that these values do not consider RF exposure requirements.



CALCULATION MAX ANTENNA GAIN:

Maximum antenna gain to comply with MPE limits for FCC

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Equivalent conducted output power (mW)	MPE Limit (mW/cm ²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
FDD 26 (Part 22)	NB-IOT / CAT M	100.0%	827.0	25.0	316.23	316.23	0.5513	9.4	20
eFDD 2	NB-IOT / CAT M	100.0%	1850.7	25.0	316.23	316.23	1.0000	12.0	20
eFDD 4	NB-IOT / CAT M	100.0%	1710.7	25.0	316.23	316.23	1.0000	12.0	20
eFDD 5	NB-IOT / CAT M	100.0%	824.7	25.0	316.23	316.23	0.5498	9.4	20
eFDD 12	NB-IOT / CAT M	100.0%	699.7	25.0	316.23	316.23	0.4665	8.7	20
eFDD 13	NB-IOT / CAT M	100.0%	779.5	25.0	316.23	316.23	0.5197	9.2	20
eFDD 25	NB-IOT / CAT M	100.0%	1850.7	25.0	316.23	316.23	1.0000	12.0	20
eFDD 26 (Part 90)	NB-IOT / CAT M	100.0%	814.0	25.0	316.23	316.23	0.5427	9.4	20
eFDD 66	NB-IOT / CAT M	100.0%	1710.7	25.0	316.23	316.23	1.0000	12.0	20
eFDD 71	NB-IOT / CAT M	100.0%	665.5	25.0	316.23	316.23	0.4437	8.5	20
eFDD 85	NB-IOT / CAT M	100.0%	700.5	25.0	316.23	316.23	0.4670	8.7	20
eFDD 8	NB-IOT / CAT M	100.0%	897.5	25.0	316.23	316.23	0.5983	9.8	20

Maximum antenna gain to comply with MPE limits for Industry Canada

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Equivalent conducted output power (mW)	MPE Limit (mW/cm ²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
eFDD 26	NB-IOT / CAT M	100%	827.0	25.0	316.23	316.23	0.2582	6.1	20
eFDD 2	NB-IOT / CAT M	100%	1850.7	25.0	316.23	316.23	0.4477	8.5	20
eFDD 4	NB-IOT / CAT M	100%	1710.7	25.0	316.23	316.23	0.4243	8.3	20
eFDD 5	NB-IOT / CAT M	100%	824.7	25.0	316.23	316.23	0.2577	6.1	20
eFDD 12	NB-IOT / CAT M	100%	699.7	25.0	316.23	316.23	0.2303	5.6	20
eFDD 13	NB-IOT / CAT M	100%	779.5	25.0	316.23	316.23	0.2480	6.0	20
eFDD 25	NB-IOT / CAT M	100%	1850.7	25.0	316.23	316.23	0.4477	8.5	20
eFDD 66	NB-IOT / CAT M	100%	1710.7	25.0	316.23	316.23	0.4243	8.3	20
eFDD 71	NB-IOT / CAT M	100%	665.5	25.0	316.23	316.23	0.2226	5.5	20
eFDD 85	NB-IOT / CAT M	100%	700.5	25.0	316.23	316.23	0.2305	5.6	20

Output power values are derived from the manufacturer's Tune-up values + tolerance range.



Band CAT M1	Max gain to be used to comply with EIRP Limits	Max gain to be used to comply with FCC MPE Limits	Max gain to be used to comply with IC MPE Limits	Maximum gain to be compliant with all limits
FDD 26 (22)	17.5	9.4	6.1	6.1
eFDD 2	10.6	12.0	8.5	8.5
eFDD 4	7.7	12.0	8.3	7.7
eFDD 5	17.4	9.4	6.1	6.1
eFDD 12	12.1	8.7	5.6	5.6
eFDD 13	12.0	9.2	6.0	6.0
eFDD 25	10.3	12.0	8.5	8.5
eFDD 26 (90)	7.1	9.4	N/A	7.1
eFDD 66	7.5	12.0	8.3	7.5
eFDD 71	11.8	8.5	5.5	5.5
eFDD 85	12.5	8.7	5.6	5.6
eFDD 8	12.4	9.8	N/A	9.8

Band NB-IOT	Max gain to be used to comply with EIRP Limits	Max gain to be used to comply with FCC MPE Limits	Max gain to be used to comply with IC MPE Limits	Maximum gain to be compliant with all limits
FDD 26 (22)	18.0	9.4	6.1	6.1
eFDD 2	10.4	12.0	8.5	8.5
eFDD 4	7.3	12.0	8.3	7.3
eFDD 5	18.0	9.4	6.1	6.1
eFDD 12	12.3	8.7	5.6	5.6
eFDD 13	12.6	9.2	6.0	6.0
eFDD 25	10.4	12.0	8.5	8.5
eFDD 26 (90)	7.6	9.4	N/A	7.6
eFDD 66	7.2	12.0	8.3	7.2
eFDD 71	12.5	8.5	5.5	5.5
eFDD 85	12.2	8.7	5.6	5.6
eFDD 8	12.4	9.8	N/A	9.8

Where the maximum antenna gain allowed per MPE limits exceeds the maximum antenna gain permitted under EIRP limits, the lower value shall be considered to maintain compliance.



4. Information on the Testing Laboratories

We, Huarui 7layers High Technology (Suzhou) Co., Ltd. ,were founded in 2020 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

Huarui 7Layers High Technology (Suzhou) Co., Ltd.

Lab Address:

Tower N, Innovation Center, 88 Zhuyi Road, High-tech District, Suzhou City, Anhui Province

Accredited Test Lab Cert 6613.01

If you have any comments, please feel free to contact us at the following:

Suzhou EMC/RF Lab:

Tel: +86 (0557) 368 1008

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