RF Exposure and Maximum ERP/EIRP Assessment

for

LEXI-R422

CAT-M1 /NB-IoT Data Modules

FCC ID: XPYUBX22VA03
IC: 8595A-UBX22VA03

Assessment Reference: MDE_UBLOX_2308_MPE_02

Test Laboratory:
7layers GmbH
Borsigstraße 11
40880 Ratingen
Germany

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0 Summary

0.1 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:

OET Bulletin 65 Edition 97-01 August 1997
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

Report version control			
Rev Version	**Release date**	**Changes**	**Version validity**
-	2024-01-11	Initial version	Invalid

Responsible for Accreditation Scope:

Responsible for Report:

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7layers GmbH
Address	Borsigstr. 11 40880 Ratingen Germany
FCC accreditation	Designation Number: DE0015 Test Firm Registration #: 929146
Industry Canada Test Site Acceptance	CAB identifier: DE0007 Test Firm Registration #: 3699A

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01 DAkkS D-PL-12140-01-02 DAkkS D-PL-12140-01-03
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Andreas Petz Dipl.-Ing. Marco Kullik
Report Template Version:	2023-08-02, V19

1.2 Project Data

Responsible for assessment and report:	Patrick Lomax
Date of Report:	2024-01-11

1.3 Applicant Data

Company Name:	u-blox AG
Address:	Zürcherstrasse 68, CH-8800 Thalwil Switzerland
Contact Person:	Giulio Comar

1.4 Manufacturer Data

Company Name:	please see applicant data
Address:	
Contact Person:	

2 Test object Data

2.1 General EUT Description

Equipment under Test	LEXI-R422
Type Designation:	LEXI-R422
Kind of Device:	LTE CAT-M1 / NB-IoT / GSM/ EGPRS Module
GSM MSC/LTE CAT	EGPRS MSC33/ CAT-M1 / NB2
FCC ID:	XPYUBX22VA03
IC ID:	8595A-UBX22VA03

General product description:

The EUTs are Cellular radio modules supporting CAT-M1/NB-IoT and GSM.

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	HW Status	SW Status
CAT-M1 / NB-IoT Data Modules	LEXI-R422	LEXI-R422	UBX-427C00	01.25,A01.11

Remark: EUT is equipped with a temporary antenna connector. The Module is not sold with a predefined antenna.

3 Evaluation Results

3.1 Maximum ERP / EIRP

Standard	Frequency Band
FCC 47 CFR §22.913 ISED RSS-132, Issue 4	GSM 850/ eFDD5/ eFDD26
FCC 47 CFR §24.232 ISED RSS-133 Issue 6, Amendment 1	GSM 1900 / 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
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

3.1.1 Test Limits

For the 850MHz band, FCC §22.913 states that the maximum ERP of this device shall not exceed 7 Watts. IC SRSP-503 Issue 7, states that this device shall not exceed a maximum EIRP of 11.5 Watts
For the purposes of this test report, the 7 Watt ERP limit stipulated in FCC §22.913 has been converted to an equivalent EIRP value of 11.5 Watts.
For all other limits, refer to the values stipulated in the corresponding tables.

3.1.2 Test Protocol

Maximum antenna gain to comply with EIRP limits for FCC and Industry Canada

Band	Mode	Duty Cycle	Frequency Range (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	FCC EIRP limit (mW)	Maximum antenna gain to meet EIRP Limit (dBi)
850	GSM	50.0%	824.2 - 848.8	31.94	1563.1476	11484	8.7
1900	GSM	50.0%	1850.2 - 1909.8	29.26	843.33476	2000	3.8
eFDD 2	CAT M	100.0%	1850-1910	22.32	170.60824	2000	10.7
eFDD 4	CAT M	100.0%	1710-1755	22.89	194.53601	1000	7.1
eFDD 5	CAT M	100.0%	824 - 849	22.92	195.88447	11484	17.7
eFDD 12	CAT M	100.0%	699-716	23.25	211.3489	4920	13.7
eFDD 13	CAT M	100.0%	777-787	23.11	204.64446	4920	13.8
eFDD 25	CAT M	100.0%	1850–1915	22.75	188.36491	2000	10.3
eFDD 26	CAT M	100.0%	814–849	23.17	207.49135	11484	17.4
eFDD 66	CAT M	100.0%	1710-1780	23.32	214.78305	1000	6.7
eFDD 8	CAT M	100.0%	898-890	22.96	197.69696	4920	14.0

Maximum antenna gain to comply with EIRP limits for FCC and Industry Canada

Band	Mode	Duty Cycle	Frequency Range (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	FCC EIRP limit (mW)	Maximum antenna gain to meet EIRP Limit (dBi)
eFDD 2	NB-IOT	100.0%	1850-1910	21.22	132.43415	2000	11.8
eFDD 4	NB-IOT	100.0%	1710-1755	21.54	142.56076	1000	8.5
eFDD 5	NB-IOT	100.0%	824 - 849	22.01	158.85467	11484	18.6
eFDD 12	NB-IOT	100.0%	699-716	21.48	140.60475	4920	15.4
eFDD 13	NB-IOT	100.0%	777-787	22.16	164.43717	4920	14.8
eFDD 66	NB-IOT	100.0%	1710-1780	22.27	168.6553	1000	7.7
eFDD 85	NB-IOT	100.0%	698-716	21.46	139.95873	4920	15.5
eFDD 8	NB-IOT	100.0%	898-890	21.73	148.93611	4920	15.2

3.1.3 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.

3.2 RF Exposure Evaluation for Module

Standards
OET Bulletin 65 Edition 97-01 August 1997
RSS-102 Issue 5 – March 2015 AMD 1 (February 2, 2021)

3.2.1 Test limits

As specified in Table 1B of 47 CFR 1.1310 – Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure.

Frequency range (MHz)	*Power density (mW/cm²)*
300 – 1,500	f/1500
1,500 – 100,000	1.0

Limits specified per RSS-102, Issue 5.

Frequency range (MHz)	*Power density (W/m²)*	*Power density (mW/cm²)*
300 – 6000	$0.02619\ f^{0.6834}$	*mW/cm² = W/m² * 0.1*

Equation OET bulletin 65, page 18, edition 97-01: $S = \frac{PG}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$

Where:

S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the centre of radiation of the antenna

3.2.2 Test Protocol

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/cm²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
850	GSM	50%	824.2	33.5	2238.72	1119.44	0.2576	**0.6**	20
1900	GSM	50%	1850.2	30.5	1122.02	561.05	0.4477	**6.0**	20
eFDD 2	CAT M	100%	1850.7	25.0	316.23	316.23	0.4477	**8.5**	20
eFDD 4	CAT M	100%	1710.7	25.0	316.23	316.23	0.4243	**8.3**	20
eFDD 5	CAT M	100%	824.7	25.0	316.23	316.23	0.2577	**6.1**	20
eFDD 12	CAT M	100%	699.7	25.0	316.23	316.23	0.2303	**5.6**	20
eFDD 13	CAT M	100%	779.5	25.0	316.23	316.23	0.2480	**6.0**	20
eFDD 25	CAT M	100%	1850.7	25.0	316.23	316.23	0.4477	**8.5**	20
eFDD 26	CAT M	100%	824.7	25.0	316.23	316.23	0.2577	**6.1**	20
eFDD 66	CAT M	100%	1710.7	25.0	316.23	316.23	0.4243	**8.3**	20

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/cm²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
850	GSM	50%	824.2	33.5	2238.72	1119.44	0.5495	**3.9**	20
1900	GSM	50%	1850.2	30.5	1122.02	561.05	1.0000	**9.5**	20
eFDD 2	CAT M	100.0%	1850.7	25	316.23	316.23	1.0000	**12.0**	20
eFDD 4	CAT M	100.0%	1710.7	25	316.23	316.23	1.0000	**12.0**	20
eFDD 5	CAT M	100.0%	824.7	25	316.23	316.23	0.5498	**9.4**	20
eFDD 12	CAT M	100.0%	699.7	25	316.23	316.23	0.4665	**8.7**	20
eFDD 13	CAT M	100.0%	779.5	25	316.23	316.23	0.5197	**9.2**	20
eFDD 25	CAT M	100.0%	1850.7	25	316.23	316.23	1.0000	**12.0**	20
eFDD 26	CAT M	100.0%	824.7	25	316.23	316.23	0.5498	**9.4**	20
eFDD 66	CAT M	100.0%	1710.7	25	316.23	316.23	1.0000	**12.0**	20
eFDD 8	CAT M	100.0%	898.0	25	316.23	316.23	0.5987	**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/cm²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
eFDD 2	NB-IOT	100%	1850.7	25.0	316.23	316.23	0.4477	**8.5**	20
eFDD 4	NB-IOT	100%	1710.7	25.0	316.23	316.23	0.4243	**8.3**	20
eFDD 5	NB-IOT	100%	824.7	25.0	316.23	316.23	0.2577	**6.1**	20
eFDD 12	NB-IOT	100%	699.7	25.0	316.23	316.23	0.2303	**5.6**	20
eFDD 13	NB-IOT	100%	779.5	25.0	316.23	316.23	0.2480	**6.0**	20
eFDD 66	NB-IOT	100%	1710.7	25.0	316.23	316.23	0.4243	**8.3**	20
eFDD 85	NB-IOT	100%	700.5	25.0	316.23	316.23	0.2305	**5.6**	20

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/cm²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
eFDD 2	NB-IOT	100.0%	1850.7	25	316.23	316.23	1.0000	**12.0**	20
eFDD 4	NB-IOT	100.0%	1710.7	25	316.23	316.23	1.0000	**12.0**	20
eFDD 5	NB-IOT	100.0%	824.7	25	316.23	316.23	0.5498	**9.4**	20
eFDD 12	NB-IOT	100.0%	699.7	25	316.23	316.23	0.4665	**8.7**	20
eFDD 13	NB-IOT	100.0%	779.5	25	316.23	316.23	0.5197	**9.2**	20
eFDD 66	NB-IOT	100.0%	1710.7	25	316.23	316.23	1.0000	**12.0**	20
eFDD 85	NB-IOT	100.0%	700.5	25	316.23	316.23	0.4670	**8.7**	20
eFDD 8	NB-IOT	100.0%	898.0	25	316.23	316.23	0.5987	**9.8**	20

3.2.3 Conclusion

Band	Mode	Max gain for FCC MPE Limits	Max gain for Industry Canada MPE Limits	Maximum gain to be compliant with all MPE limits
850	GSM	3.9	0.6	0.6
1900	GSM	9.5	6.0	6.0
eFDD 2	CAT M	12.0	8.5	8.5
eFDD 4	CAT M	12.0	8.3	8.3
eFDD 5	CAT M	9.4	6.1	6.1
eFDD 12	CAT M	8.7	5.6	5.6
eFDD 13	CAT M	9.2	6.0	6.0
eFDD 25	CAT M	12.0	8.5	8.5
eFDD 26	CAT M	9.4	6.1	6.1
eFDD 66	CAT M	12.0	8.3	8.3
eFDD 8	CAT M	9.8	-	9.8

Gain expressed in dBi

Band	Mode	Max gain for FCC MPE Limits	Max gain for Industry Canada MPE Limits	Maximum gain to be compliant with all MPE limits
eFDD 2	NB-IOT	12.0	8.5	8.5
eFDD 4	NB-IOT	12.0	8.3	8.3
eFDD 5	NB-IOT	9.4	6.1	6.1
eFDD 12	NB-IOT	8.7	5.6	5.6
eFDD 13	NB-IOT	9.2	6.0	6.0
eFDD 66	NB-IOT	12.0	8.3	8.3
eFDD 85	NB-IOT	8.7	5.6	5.6
eFDD 8	NB-IOT	9.8	-	9.8

Gain expressed in dBi