InterLab

RF Exposure and Maximum ERP/EIRP Assessment

For

LARA-R204

FCC ID XPY1EIQN2NN

IC: 8595A-1EIQN2NN

Assessment Reference: MDE_UBLOX_1603_MPEa

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 UMTS/LTE radio module. Including RF Exposure for use with co-located radios on generic host device.

Applicable FCC Rules and ISED Requirements

For RF Exposure:
OET Bulletin 65 Edition 97-01 August 1997
FCC 47 CFR §1.1307
FCC 47 CFR §1.1310
RSS-102 Issue 5 – March 2015

For Maximum ERP/EIRP:

FCC 47 CFR §27.50(d)
RSS-139, Issue 2 / SRSP-513
RSS-130, Issue 2 / SRSP-518

Report version control			
Version	**Release date**	**Changes**	**Version validity**
001	22.09.2016	Initial version	Valid

Responsible for Accreditation Scope:

Responsible for Report:

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers GmbH
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

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

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Andreas Petz Dipl.-Ing. Marco Kullik
Report Template Version:	2016-08-30

1.2 Project Data

Responsible for assessment and report:	Mr. Patrick Lomax
Date of Report:	2016-09-22

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	LARA-R204 LTE Data Module
Type Designation:	LARA-R204
Kind of Device:	LTE Data Module
LTE CAT	1
FCC ID:	XPY1EIQN2NN
IC Number:	8595A-1EIQN2NN

General product description:

The EUT is Cellular radio module supporting LTE bands eFDD4 and eFDD13.

2.2 EUT Main components

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

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
EUT A (Code: DE1015039F01)	LTE Module	LARA-R204	357648070011198	266002	31.00
Remark: EUT A is equipped with a temporary antenna connector. The Module is not sold with a predefined antenna.					

NOTE: The short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	HW Status	SW Status	Serial no.	FCC ID
AE 1	AC/DC converter	UUX324-1215	-	-	E09-0291981	–
AE 2	Evaluation test board	EVB-WL3	NO_EVK_CS_191A00	-	-	-

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status	FCC ID
N/A						–

3 Evaluation Results

3.1 Maximum ERP / EIRP

Standard	Frequency Band
FCC 47 CFR §22.913 IC RSS-132, Issue 3	NA
FCC 47 CFR §24.232 IC RSS-133 Issue 6	NA
FCC 47 CFR §27.50(d) RSS-139, Issue 2 / SRSP-513 RSS-130, Issue 1 / SRSP-518	(FDD4,13 LTE)

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 ERIP value of 11.5 Watts.

For all other limits, refer to the values stipulated in the corresponding tables.

3.1.2 Test Protocol

Band	Mode	Duty Cycle (%)	Frequency (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Freq of highest power (MHz)	FCC / IC EIRP limit (mW)	Maximum antenna gain to meet EIRP Limit (dBi)
eFDD 4	LTE	100.0%	1710-1755	22.45	175.7923614	1732.50	1000	7.6
eFDD13	LTE	100.0%	779.5-784.5	22.09	161.8080038	784.50	4920	14.8

3.1.3 Conclusion

All gains in (dBi) Band	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
eFDD 4	7.6	13.0	9.3	7.6
eFDD 13	14.8	10.2	7.0	7.0

3.2 RF Exposure Evaluation for Module

Standards
OET Bulletin 65 Edition 97-01 August 1997
FCC 47 CFR §1.1307
FCC 47 CFR §1.1310
RSS-102 Issue 5 – March 2015

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

MPE Calculation using antenna gain which meets MPE and EIRP Limits for RSS-102, Annex A **Informational only**

Band	Mode	Frequency (MHZ)	Maximum Conducted output power (dBm)	Max Cond output power (mW)	FCC MPE Limit (mW/cm²)	IC MPE Limit (mW/cm²)	Separation distance (cm)	MPE using gain for overall compliance (mW/cm²)
eFDD 4	LTE	1732.5	24	251.19	1.0000	0.4280	20	0.284269661
eFDD 13	LTE	782.0	24	251.19	0.5213	0.2485	20	0.248507311

3.2.2 Test Protocol

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 4	LTE	100.0%	1732.5	24	251.19	251.19	1.0000	**13.0**	20
eFDD13	LTE	100.0%	782.0	24	251.19	251.19	0.5213	**10.2**	20

* Conducted output power values bases on "Tune-up" information provided by manufacturer.

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 4	LTE	100.0%	1732.5	24.0	251.19	251.19	0.4280	**9.3**	20
eFDD13	LTE	100.0%	782.0	24.0	251.19	251.19	0.2485	**7.0**	20

* Conducted output power values bases on "Tune-up" information provided by manufacturer.

3.2.3 Conclusion

Band	Max gain for FCC MPE Limits	Max gain for Industry Canada MPE Limits	Maximum gain to be compliant with all limits
eFDD 4	13.0	9.3	7.6
eFDD13	10.2	7.0	7.0

Gains in dBi

3.3 RF Exposure Evaluation for multiple transmitters in co-location

Standards
OET Bulletin 65 Edition 97-01 August 1997
FCC 47 CFR §1.1307
FCC 47 CFR §1.1310
RSS-102 Issue 5 – March 2015

3.3.1 Co-Location Considerations

The calculation below is used to consider situations in which simultaneous exposure to fields of different frequencies occur. The calculation is performed by the sum of each relative exposure for each equipment according to the following criteria.

$$\sum_{1}^{N} \frac{S_{eqn}}{S_{Limn}} = \frac{S_{eq1}}{S_{Lim1}} + \frac{S_{eq2}}{S_{Lim2}} + \ldots + \frac{S_{eqN}}{S_{LimN}} \leq 1$$

Where:

S_{eq} is the power density of the electromagnetic field at a given distance by a specific transmitter and a defined frequency.

S_{lin} is the MPE limit for the frequency being evaluated.

3.3.2 Assumptions

1. Primary transmitter does not support power reduction for multiple time slots on the uplink.
2. Antenna separation from module to human body is ≥ 20cm.
3. Separation distance between co-located transmitting antennas is 0cm.
4. Hypothetical Bluetooth radio is assumed to have an output power of 9.5dBm and an antenna gain of 4dBi.
5. Hypothetical WLAN radio is assumed to have an output power of 19dBm and an antenna gain of 5dBi.

3.3.3 Test Protocol

The below table is to determine the MPE values using the maximum gain values obtained in section 3.3.4 of this document.

FOR FCC ONLY informational

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	MPE Limit (mW/cm²)	MPE Value using Max gain (mW/cm²)	Separation distance (cm)	Verdict
eFDD 4	LTE	100.0%	1732.5	24	251.19	1.0000	**0.2876**	20	Pass
eFDD13	LTE	100.0%	782.0	24	251.19	0.5213	**0.4664**	20	Pass

* Conducted output power values bases on "Tune-up" information provided by manufacturer.

FOR Industry Canada ONLY informational

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	MPE Limit (mW/cm²)	MPE Value using Max gain (mW/cm²)	Separation distance (cm)	Verdict
eFDD 4	LTE	100.0%	1732.5	24	251.19	0.4280	**0.2876**	20	PASS
eFDD13	LTE	100.0%	782.0	24	251.19	0.2485	**0.2232**	20	PASS

MPE Values for the generic Bluetooth and WLAN radios operating alone. These values are used to calculate the relative exposure for simultaneous transmission with the primary transmitter.

MPE Calculation for Single Transmitter installed in Generic host for FCC								
Radio type	Duty Cycle	ERP (mW)	ERP Equivalent (mW)	MPE Limit (mW/cm²)	Maximum antenna gain dBi	Power density (mW/cm²)	Separation distance (cm)	Verdict
Bluetooth	64%	8.91	3.72	1.0000	4.0	**0.0019**	20	Pass
WLAN	100%	79.43	79.43	1.0000	5.0	**0.0500**	20	Pass

MPE Calculation for Single Transmitter installed in Generic host for Industry Canada								
Radio type	Duty Cycle	ERP (mW)	ERP Equivalent (mW)	MPE Limit (mW/cm²)	Maximum antenna gain dBi	Power density (mW/cm²)	Separation distance (cm)	Verdict
Bluetooth	64%	8.91	3.72	0.54	4.00	**0.0019**	20.00	Pass
WLAN	100%	79.43	79.43	0.54	5.00	**0.0500**	20.00	Pass

Below are the relative exposure values for the primary, secondary and combined primary + secondary transmitters for both FCC and Industry Canada limits.

OP mode-1

Relative exposure for Primary Transmitter for FCC							
OP-Mode	Mode	Output power (mW)	Frequency (MHZ)	S_{eq} (mW/cm²)	S_{lin} (mW/cm²)	$\frac{S_{eq}}{S_{Lin}}$	Verdict
eFDD 4	LTE	**251.1886**	1732.5	**0.2876**	1.0000	0.28756135	Pass
eFDD13	LTE	**251.1886**	782.0	**0.4664**	0.5213	0.89457142	Pass

Relative exposure for Primary Transmitter for Industry Canada							
OP-Mode	Mode	Output power (mW)	Frequency (MHZ)	S_{eq} (mW/cm²)	S_{lin} (mW/cm²)	$\frac{S_{eq}}{S_{Lin}}$	Verdict
eFDD 4	LTE	**251.1886**	1732.5	**0.2876**	0.4280	0.671870726	Pass
eFDD13	LTE	**251.1886**	782.0	**0.2232**	0.2485	0.898209239	Pass

Relative exposure for Secondary transmitter for FCC					
OP-Mode	Transmitter	Output power (mW)	S_{eq} (mW/cm²)	S_{lin} (mW/cm²)	$\frac{S_{eq}}{S_{Lin}}$
Single radio	Bluetooth	3.72	**0.0019**	1.0000	0.001856652
Single radio	WLAN	79.43	**0.0500**	1.0000	0.049972435
Co-located	Bluetooth	3.72	**0.0019**	1.0000	0.001856652
	WLAN	79.43	**0.0500**	1.0000	0.049972435

Relative exposure for Secondary transmitter for Industry Canada					
OP-Mode	Transmitter	Output power (mW)	S_{eq} (mW/cm²)	S_{lin} (mW/cm²)	$\frac{S_{eq}}{S_{Lin}}$
Single radio	Bluetooth	3.72	**0.0019**	0.5410	0.003431873
Single radio	WLAN	79.43	**0.0500**	0.5410	0.092370053
Co-located	Bluetooth	3.72	**0.0019**	0.5410	0.003431873
	WLAN	79.43	**0.0500**	0.5410	0.092370053

Simultaneous exposure of Primary and Secondary transmitter installed in generic host device for FCC					
OP-Mode	Transmitter	Frequency (MHZ)	Maximum S_{eq} / S_{Lin} (mW/cm²)	Maximum $S_{pri}/S_{lim\_pri} + S_{sec} / S_{lin\_Sec}$	Compliance Maximum $(S_{pri}/S_{lim\_pri}) + (S_{sec} / S_{lin\_Sec}) < 1$
	Bluetooth	2441	**0.0019**		
Co-located	LARA R204	eFDD4	**0.2876**	0.2894	Compliant
	WLAN	2437	**0.0924**		
Co-located	LARA R204	eFDD4	**0.2876**	0.3799	Compliant
	Bluetooth	2441	**0.0019**		
	WLAN	2437	**0.0500**		
Co-located	LARA R204	eFDD4	**0.2876**	0.3394	Compliant
	Bluetooth	2441	**0.0019**		
Co-located	LARA R204	eFDD 13	**0.8946**	0.8964	Compliant
	WLAN	2437	**0.0019**		
Co-located	LARA R204	eFDD 13	**0.8946**	0.8964	Compliant
	Bluetooth	2441	**0.0019**		
	WLAN	2437	**0.0924**		
Co-located	LARA R204	eFDD 13	**0.8946**	0.9888	Compliant

Simultaneous exposure of Primary and Secondary transmitter installed in generic host device for Industry Canada					
OP-Mode	Transmitter	Frequency (MHZ)	Maximum S_{eq} / S_{Lin} (mW/cm²)	Maximum S_{pri}/S_{lim_pri} + S_{sec} / S_{lin_Sec}	Compliance Maximum (S_{pri}/S_{lim_pri}) + (S_{sec} / S_{lin_Sec}) < 1
Co-located	Bluetooth	2441	**0.0034**		
	LARA R204	eFDD4	**0.6719**	0.6753	Compliant
Co-located	WLAN	2437	**0.0924**		
	LARA R204	eFDD4	**0.6719**	0.7642	Compliant
Co-located	Bluetooth	2441	**0.0034**		
	WLAN	2437	**0.0924**		
	LARA R204	eFDD4	**0.6719**	0.7677	Compliant
Co-located	Bluetooth	2441	**0.0034**		
	LARA R204	eFDD 13	**0.8982**	0.9016	Compliant
Co-located	WLAN	2437	**0.0924**		
	LARA R204	eFDD 13	**0.8982**	0.9906	Compliant
Co-located	Bluetooth	2441	**0.0034**		
	WLAN	2437	**0.0924**		
	LARA R204	eFDD 13	**0.8982**	0.9940	Compliant

When operating the primary transmitter simultaneously with a generic Bluetooth and WLAN radio, the following antenna gains can be used with the module LARA-R204 while still complying with the exposure limits.

Band	dBi (For FCC)	dBi (For Industry Canada)
eFDD 4	7.6	7.6
eFDD 13	9.7	6.5