

Inter**Lab**[®]

RF Exposure and Maximum ERP/EIRP Assessment

For

TOBY-R200

FCC ID XPY1EHM44NN

IC: 8595A-1EHM44NN

Assessment Reference: MDE_UBLOX_1626_MPEa Rev0

Test Laboratory:

7layers GmbH
Borsigstraße 11
40880 Ratingen
Germany

Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

7layers GmbH
Borsigstraße 11
40880 Ratingen, Germany
T +49 (0) 2102 749 0
F +49 (0) 2102 749 350
www.7layers.com

Registergericht registered in:
Geschäftsführer /
Managing Directors:
Frank Spiller
Bernhard Retka
Alexandre Norré-Oudard

Düsseldorf, HRB 75554
USt-IdNr VAT No.:
DE203159652
TAX No. 147/5869/0385
A Bureau Veritas Group Company

Table of Contents

0	Summary	3
0.1	Technical Report Summary	3
1	Administrative Data	4
1.1	Testing Laboratory	4
1.2	Project Data	4
1.3	Applicant Data	4
1.4	Manufacturer Data	4
2	Test object Data	5
2.1	General EUT Description	5
2.2	EUT Main components	5
2.3	Ancillary Equipment	5
2.4	Auxiliary Equipment	6
3	Evaluation Results	7
3.1	Maximum ERP / EIRP	7
3.2	RF Exposure Evaluation for Module	9
3.3	RF Exposure Evaluation for multiple transmitters in co-location	12

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 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 5 – March 2015

For Maximum ERP/EIRP:

FCC 47 CFR §22.913

IC SRSP-503 Issue 7, September 2008

FCC 47 CFR §24.232

IC SRSP-510 Issue 5, February 2009

FCC 47 CFR §27.50(d)

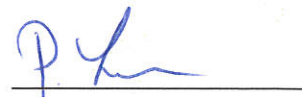
RSS-139, Issue 2 / SRSP-513

Report version control			
Rev Version	Release date	Changes	Version validity
000	2017.01.03	Initial version	Valid

Responsible for
Accreditation Scope:



Responsible
for Report:



1 Administrative Data

1.1 Testing Laboratory

Company Name: 7 Layers GmbH

Address Borsigstr. 11
40880 Ratingen
Germany

This facility has been fully described in a report submitted to the FCC and ISED and accepted under the registration number 96716 and ISED 3699A-1.

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

Laboratory accreditation no.: DAkkS D-PL-12140-01-00

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: 2017-01-03

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	GSM/UMTS /LTE Voice/Data Module
Type Designation:	TOBY-R200
Kind of Device:	GSM/UMTS/LTE Voice/Data Module
GSM MSC/UMTS/LTE CAT	33 / 8 / 1
FCC ID:	XPY1EHM44NN
IC Number:	8595A-1EHM44NN

General product description:

The EUT is Cellular radio module supporting GSM/WCDMA/HSDPA/HSUPA/LTE

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: DE1015040aT06)	GSM/UMTS/LTE Module	TOBY-R200	352848080028158	283A00	30.26
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	(GSM 850/FDD5 WCDMA/HSUPA/HSDPA/LTE)
FCC 47 CFR §24.232 IC RSS-133 Issue 6	(GSM 1900/FDD2 WCDMA/HSUPA/HSDPA/LTE)
FCC 47 CFR §27.50(d) RSS-139, Issue 2 / SRSP-513	(FDD4,12 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 correction	Frequency (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Freq of highest power MHz	FCC EIRP limit (mW)	Maximum antenna gain to meet EIRP Limit (dBi)
850	GSM	-3.01 dBm	836.2 - 848.8	32.78	1896.7059	848.80	11484	7.8
1900	GSM	-3.01 dBm	1850.2 - 1909.8	30.8	1202.2644	1909.80	2000	2.2
FDD 2	UMTS	0	1850 - 1907.6	24.68	293.76497	1907.60	2000	8.3
FDD 5	UMTS	0	824 - 846.6	24.32	270.39584	836.00	11484	16.3
eFDD 2	LTE	0	1850-1910	21.86	153.4617	1902.50	2000	11.2
eFDD 4	LTE	0	1710-1755	22.24	167.49429	1732.50	1000	7.8
eFDD 5	LTE	0	824 - 849	23.21	209.41125	825.50	11484	17.4
eFDD12	LTE	0	698-716	22	158.48932	711.00	4921	14.9

3.1.3 Conclusion

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
850	7.8	4.0	0.7	0.7
1900	2.2	9.5	6.1	2.2
FDD 2	8.3	12.5	9.1	8.3
FDD 5	16.3	10.0	6.7	6.7
eFDD 2	11.2	13.0	9.6	9.6
eFDD 4	7.8	13.0	9.3	7.8
eFDD 5	17.4	10.4	7.1	7.1
eFDD12	14.9	9.8	6.7	6.7

The above table lists the gains which conform to both the EIRP limits and the MPE limits for both ISSED and FCC. Gain expressed in dBi.

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/cm ²)
300 – 1,500	f/1500
1,500 – 100,000	1.0

Limits specified per RSS-102, Issue 5.

Frequency range (MHz)	Power density (W/m ²)	Power density (mW/cm ²)
300 – 6000	$0.02619 f^{0.6834}$	$mW/cm^2 = W/m^2 * 0.1$

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/cm ²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
850	GSM	-3.01 dBm	848.8	33.5	2238.72	1119.44	0.2628	0.7	20
1900	GSM	-3.01 dBm	1909.8	30.5	1122.02	561.05	0.4575	6.1	20
FDD 2	UMTS	0	1907.6	24.5	281.84	281.84	0.4571	9.1	20
FDD 5	UMTS	0	836.0	24.5	281.84	281.84	0.2601	6.7	20
eFDD 2	LTE	0	1902.5	24.0	251.19	251.19	0.4563	9.6	20
eFDD 4	LTE	0	1732.5	24.0	251.19	251.19	0.4280	9.3	20
eFDD 5	LTE	0	825.5	24.0	251.19	251.19	0.2579	7.1	20
eFDD12	LTE	0	711.0	24.0	251.19	251.19	0.2329	6.7	20

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

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)
850	GSM	-3.01 dBm	848.8	33.5	2238.72	1119.44	0.5659	4.0	20
1900	GSM	-3.01 dBm	1909.8	30.5	1122.02	561.05	1.0000	9.5	20
FDD 2	UMTS	0	1907.6	24.5	281.84	281.84	1.0000	12.5	20
FDD 5	UMTS	0	836.0	24.5	281.84	281.84	0.5573	10.0	20
eFDD 2	LTE	0	1902.5	24	251.19	251.19	1.0000	13.0	20
eFDD 4	LTE	0	1732.5	24	251.19	251.19	1.0000	13.0	20
eFDD 5	LTE	0	825.5	24	251.19	251.19	0.5503	10.4	20
eFDD12	LTE	0	711.0	24	251.19	251.19	0.4740	9.8	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
850	4.0	0.7	0.7
1900	9.5	6.1	6.1
FDD 2	12.5	9.1	9.1
FDD 5	10.0	6.7	6.7
eFDD 2	13.0	9.6	9.6
eFDD 4	13.0	9.3	9.3
eFDD 5	10.4	7.1	7.1
eFDD12	9.8	6.7	6.7

Gain expressed 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.

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

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 ≥ 20 cm.
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.

OP mode-1 – FOR FCC ONLY

Band	Mode	Duty Cycle Correction	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	FCC MPE Limit (mW/cm ²)	Power Density (mW/cm ²)	Separation distance (cm)	Verdict
850	GSM	-3.01 dBm	848.8	33.5	1119.44	0.5659	0.5342	20	Pass
1900	GSM	-3.01 dBm	1909.8	30.5	561.05	1.0000	0.1852	20	Pass
FDD 2	UMTS	0	1907.6	24.5	281.84	1.0000	0.1773	20	Pass
FDD 5	UMTS	0	836.0	24.5	281.84	0.5573	0.0889	20	Pass
eFDD 2	LTE	0	1902.5	24	251.19	1.0000	0.6588	20	Pass
eFDD 4	LTE	0	1732.5	24	251.19	1.0000	0.3011	20	Pass
eFDD 5	LTE	0	825.5	24	251.19	0.5503	0.5114	20	Pass
eFDD12	LTE	0	711.0	24	251.19	0.4740	0.4454	20	Pass

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

OP mode-1 – FOR Industry Canada ONLY

Band	Mode	Duty Cycle Correction	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	IC MPE Limit (mW/cm ²)	Power Density (mW/cm ²)	Separation distance (cm)	Verdict
850	GSM	-3.01 dBm	848.8	33.5	1119.44	0.2628	0.2359	20	PASS
1900	GSM	-3.01 dBm	1909.8	30.5	561.05	0.4575	0.1852	20	PASS
FDD 2	UMTS	0	1907.6	24.5	281.84	0.4571	0.2810	20	PASS
FDD 5	UMTS	0	836.0	24.5	281.84	0.2601	0.1119	20	PASS
eFDD 2	LTE	0	1902.5	24	251.19	0.4563	0.4062	20	PASS
eFDD 4	LTE	0	1732.5	24	251.19	0.4280	0.3011	20	PASS
eFDD 5	LTE	0	825.5	24	251.19	0.2579	0.2311	20	PASS
eFDD12	LTE	0	711.0	24	251.19	0.2329	0.2083	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/cm ²)	Maximum antenna gain dBi	Power density (mW/cm ²)	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/cm ²)	Maximum antenna gain dBi	Power density (mW/cm ²)	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.

Relative exposure for Primary Transmitter for FCC

OP-Mode	Mode	Output Power	Frequency (MHZ)	S_{eq} (mW/cm ²)	S_{lin} (mW/cm ²)	$\frac{S_{eq}}{S_{lin}}$ (mW/cm ²)	Verdict
850	GSM	1119.4379	848.8	0.5342	0.5659	0.9440965	Pass
1900	GSM	561.0480	1909.8	0.1852	1.0000	0.1852382	Pass
FDD 2	UMTS	281.8383	1907.6	0.1773	1.0000	0.1773089	Pass
FDD 5	UMTS	281.8383	836.0	0.0889	0.5573	0.1594467	Pass
eFDD 2	LTE	251.1886	1902.5	0.6588	1.0000	0.658765	Pass
eFDD 4	LTE	251.1886	1732.5	0.3011	1.0000	0.3011137	Pass
eFDD 5	LTE	251.1886	825.5	0.5114	0.5503	0.9291904	Pass
eFDD12	LTE	251.1886	711.0	0.4454	0.4740	0.9396198	Pass

Relative exposure for Primary Transmitter for ISED

OP-Mode	Mode	Output Power	Frequency (MHZ)	S_{eq} (mW/cm ²)	S_{lin} (mW/cm ²)	$\frac{S_{eq}}{S_{lin}}$ (mW/cm ²)	Verdict
850	GSM	1119.4379	848.8	0.2359	0.2628	0.8975309	Pass
1900	GSM	561.0480	1909.8	0.1852	0.4575	0.4049188	Pass
FDD 2	UMTS	281.8383	1907.6	0.2810	0.4571	0.6147662	Pass
FDD 5	UMTS	281.8383	836.0	0.1119	0.2601	0.4300899	Pass
eFDD 2	LTE	251.1886	1902.5	0.4062	0.4563	0.8902347	Pass
eFDD 4	LTE	251.1886	1732.5	0.3011	0.4280	0.703535	Pass
eFDD 5	LTE	251.1886	825.5	0.2311	0.2579	0.8960053	Pass
eFDD12	LTE	251.1886	711.0	0.2083	0.2329	0.8945968	Pass

Relative exposure for Secondary transmitter for FCC					
OP-Mode	Transmitter	Output power	S_{eq} (mW/cm ²)	S_{lin} (mW/cm ²)	$\frac{S_{eq}}{S_{lin}}$
2	Bluetooth	3.72	0.0019	1.0000	0.001856652
3	WLAN	79.43	0.0500	1.0000	0.049972435
4	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	S_{eq} (mW/cm ²)	S_{lin} (mW/cm ²)	$\frac{S_{eq}}{S_{lin}}$
2	Bluetooth	3.72	0.0019	0.5410	0.003431873
3	WLAN	79.43	0.0500	0.5410	0.092370053
4	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

Primary Band	Primary Mode	All Transmitters	Frequency (MHZ)	Maximum S_{eq} / S_{lin} (mW/cm ²)	Maximum $S_{pri} / S_{lim_pri} + S_{sec} / S_{lin_sec}$ (mW/cm ²)	Compliance Maximum $(S_{pri} / S_{lim_pri}) + (S_{sec} / S_{lin_sec}) < 1$
850	GSM	Bluetooth	2441	0.0019	0.9959	Compliant
		Wlan	2412	0.0500		
		Toby	848.8	0.9441		
1900	GSM	Bluetooth	2441	0.0019	0.2371	Compliant
		Wlan	2412	0.0500		
		Toby	1909.8	0.1852		
FDD 2	UMTS	Bluetooth	2441	0.0019	0.2291	Compliant
		Wlan	2412	0.0500		
		Toby	1907.6	0.1773		
FDD 5	UMTS	Bluetooth	2441	0.0019	0.2113	Compliant
		Wlan	2412	0.0500		
		Toby	836.0	0.1594		
eFDD 2	LTE	Bluetooth	2441	0.0019	0.7106	Compliant
		Wlan	2412	0.0500		
		Toby	1902.5	0.6588		
eFDD 4	LTE	Bluetooth	2441	0.0019	0.3529	Compliant
		Wlan	2412	0.0500		
		Toby	1732.5	0.3011		
eFDD 5	LTE	Bluetooth	2441	0.0019	0.9810	Compliant
		Wlan	2412	0.0500		
		Toby	825.5	0.9292		
eFDD12	LTE	Bluetooth	2441	0.0019	0.9914	Compliant
		Wlan	2412	0.0500		
		Toby	711.0	0.9396		

Simultaneous exposure of Primary and Secondary transmitter installed in generic host device for ISED

Primary Band	Primary Mode	Transmitter	Frequency (MHZ)	Maximum S_{eq} / S_{Lin} (mW/cm ²)	Maximum $S_{pri}/S_{lim_pri} + S_{sec} / S_{lin_Sec}$ (mW/cm ²)	Compliance Maximum $(S_{pri}/S_{lim_pri}) + (S_{sec} / S_{lin_Sec}) < 1$
850	GSM	Bluetooth	2441	0.0034	0.9933	Compliant
		Wlan	2412	0.0924		
		Toby	848.8	0.8975		
1900	GSM	Bluetooth	2441	0.0034	0.5007	Compliant
		Wlan	2412	0.0924		
		Toby	1909.8	0.4049		
FDD 2	UMTS	Bluetooth	2441	0.0034	0.7106	Compliant
		Wlan	2412	0.0924		
		Toby	1907.6	0.6148		
FDD 5	UMTS	Bluetooth	2441	0.0034	0.5259	Compliant
		Wlan	2412	0.0924		
		Toby	836	0.4301		
eFDD 2	LTE	Bluetooth	2441	0.0034	0.9860	Compliant
		Wlan	2412	0.0924		
		Toby	1902.5	0.8902		
eFDD 4	LTE	Bluetooth	2441	0.0034	0.7993	Compliant
		Wlan	2412	0.0924		
		Toby	1732.5	0.7035		
eFDD 5	LTE	Bluetooth	2441	0.0034	0.9918	Compliant
		Wlan	2412	0.0924		
		Toby	825.5	0.8960		
eFDD12	LTE	Bluetooth	2441	0.0034	0.9904	Compliant
		Wlan	2412	0.0924		
		Toby	711	0.8946		

When operating the primary transmitter simultaneously with a generic Bluetooth and WLAN radio, the following antenna gains can be used with the module TOBY-R200 while still complying with the exposure limits.

Band	dB (For FCC)	dB (For Industry Canada)
850	3.8	0.25
1900	2.2	2.2
FDD 2	5	7
FDD 5	2	2
eFDD 2	11.2	9.1
eFDD 4	7.8	7.8
eFDD 5	10.1	6.65
eFDD12	9.5	6.2