

InterLab[®]

RF Exposure and Maximum ERP/EIRP Assessment

For

TOBY-R202

FCC ID XPY1EHQ24NN

IC: 8595A-1EHQ24NN

Assessment Reference: MDE_UBLOX_1612_MPEa

Test Laboratory:

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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.

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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

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)

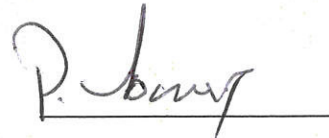
RSS-139, Issue 2 / SRSP-513

Report version control			
Version	Release date	Changes	Version validity
001	30.08.2016	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: 2016-08-30

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	UMTS/HSPA/LTE Voice/Data Module
Type Designation:	TOBY-R202
Kind of Device:	UMTS/LTE Voice/Data Module
UMTS/LTE CAT	8/1
FCC ID:	XPY1EHQ24NN
IC Number:	8595A-1EHQ24NN

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: DE1015037af03)	UMTS/LTE Module	TOBY-R202	351778080012608	257CA0	30.05
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	(FDD5 WCDMA/HSUPA/HSDPA/LTE)
FCC 47 CFR §24.232 IC RSS-133 Issue 6	(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 (%)	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)
FDD 2	UMTS	100.0%	1850 - 1907.6	24.5	281.8382931	1907.60	2000	8.5
FDD 5	UMTS	100.0%	824 - 846.6	24.5	281.8382931	836.00	11484	16.1
eFDD 2	LTE	100.0%	1850-1910	21.8	151.3561248	1902.50	2000	11.2
eFDD 4	LTE	100.0%	1710-1755	22.1	162.1810097	1732.50	1000	7.9
eFDD 5	LTE	100.0%	824 - 849	21.6	144.5439771	825.50	11484	19.0
eFDD12	LTE	100.0%	699.7-715.5	22	158.4893192	784.50	4920	14.9

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	
FDD 2	8.5	12.5	9.1	8.5	
FDD 5	16.1	10.0	6.7	6.7	
eFDD 2	11.2	13.0	9.6	9.6	
eFDD 5	19.0	10.4	7.1	7.1	
eFDD 4	7.9	13.0	9.3	7.9	
eFDD 12	14.9	9.7	6.7	6.7	

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

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/cm ²)	IC MPE Limit (mW/cm ²)	Separation distance (cm)	MPE using gain for overall compliance
FDD 2	UMTS	1907.6	24.5	281.84	1.0000	0.4571	20	0.397887694
FDD 5	UMTS	836.0	24.5	281.84	0.5573	0.2601	20	0.260110237
eFDD 2	LTE	1902.5	24	251.19	1.0000	0.4563	20	0.456259742
eFDD 4	LTE	1732.5	24	251.19	1.0000	0.4280	20	0.308127536
eFDD 5	LTE	825.5	24	251.19	0.5503	0.2579	20	0.25787315
eFDD12	LTE	707.5	24	251.19	0.4717	0.2321	20	0.232073059

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/cm ²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
FDD 2	UMTS	100.0%	1907.6	24.5	281.84	281.84	1.0000	12.5	20
FDD 5	UMTS	100.0%	836.0	24.5	281.84	281.84	0.5573	10.0	20
eFDD 2	LTE	100.0%	1902.5	24	251.19	251.19	1.0000	13.0	20
eFDD 4	LTE	100.0%	1732.5	24	251.19	251.19	1.0000	13.0	20
eFDD 5	LTE	100.0%	825.5	24	251.19	251.19	0.5503	10.4	20
eFDD12	LTE	100.0%	707.5	24	251.19	251.19	0.4717	9.7	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/cm ²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
FDD 2	UMTS	100.0%	1907.6	24.5	281.84	281.84	0.4571	9.1	20
FDD 5	UMTS	100.0%	836.0	24.5	281.84	281.84	0.2601	6.7	20
eFDD 2	LTE	100.0%	1902.5	24.0	251.19	251.19	0.4563	9.6	20
eFDD 4	LTE	100.0%	1732.5	24.0	251.19	251.19	0.4280	9.3	20
eFDD 5	LTE	100.0%	825.5	24.0	251.19	251.19	0.2579	7.1	20
eFDD12	LTE	100.0%	707.5	24.0	251.19	251.19	0.2321	6.7	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
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
eFDD13	9.7	6.7	6.7

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	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	MPE Limit (mW/cm ²)	MPE Value using Max gain	Separation distance (cm)	Verdict
FDD 2	UMTS	100.0%	1907.6	24.5	281.84	1.0000	0.3969	20	Pass
FDD 5	UMTS	100.0%	836.0	24.5	281.84	0.5573	0.2810	20	Pass
eFDD 2	LTE	100.0%	1902.5	24	251.19	1.0000	0.6588	20	Pass
eFDD 4	LTE	100.0%	1732.5	24	251.19	1.0000	0.3081	20	Pass
eFDD 5	LTE	100.0%	825.5	24	251.19	0.5503	0.4883	20	Pass
eFDD12	LTE	100.0%	707.5	24	251.19	0.4717	0.4253	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	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	MPE Limit (mW/cm ²)	MPE Value using Max gain	Separation distance (cm)	Verdict
FDD 2	UMTS	100.0%	1907.6	24.5	281.84	0.4571	0.3969	20	PASS
FDD 5	UMTS	100.0%	836.0	24.5	281.84	0.2601	0.2337	20	PASS
eFDD 2	LTE	100.0%	1902.5	24	251.19	0.4563	0.4062	20	PASS
eFDD 4	LTE	100.0%	1732.5	24	251.19	0.4280	0.3081	20	PASS
eFDD 5	LTE	100.0%	825.5	24	251.19	0.2579	0.2284	20	PASS
eFDD12	LTE	100.0%	707.5	24	251.19	0.2321	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	Power density	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	Power density	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	Frequency (MHZ)	S _{eq} (mW/cm ²)	S _{lin} (mW/cm ²)	S _{eq} / S _{lin}	Verdict
FDD 2	UMTS	281.8383	1907.6	0.3969	1.0000	0.39694516	Pass
FDD 5	UMTS	281.8383	836.0	0.2810	0.5573	0.50421469	Pass
eFDD 2	LTE	251.1886	1902.5	0.6588	1.0000	0.65876499	Pass
eFDD 4	LTE	251.1886	1732.5	0.3081	1.0000	0.30812754	Pass
eFDD 5	LTE	251.1886	825.5	0.4883	0.5503	0.8873699	Pass
eFDD12	LTE	251.1886	707.5	0.4253	0.4717	0.90176905	Pass

Relative exposure for Primary Transmitter for Industry Canada							
OP-Mode	Mode	Output power	Frequency (MHZ)	S_{eq} (mW/cm ²)	S_{lin} (mW/cm ²)	$\frac{S_{eq}}{S_{Lin}}$	Verdict
FDD 2	UMTS	281.8383	1907.6	0.3969	0.4571	0.868380341	Pass
FDD 5	UMTS	281.8383	836.0	0.2337	0.2601	0.898585162	Pass
eFDD 2	LTE	251.1886	1902.5	0.4062	0.4563	0.890234737	Pass
eFDD 4	LTE	251.1886	1732.5	0.3081	0.4280	0.719922453	Pass
eFDD 5	LTE	251.1886	825.5	0.2284	0.2579	0.885748779	Pass
eFDD12	LTE	251.1886	707.5	0.2083	0.2321	0.897618844	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					
OP-Mode	Transmitter	Frequency (MHZ)	Maximum S_{eq} / S_{Lin}	Maximum $S_{pri} / S_{lim_pri} + S_{sec} / S_{lin_Sec}$	Compliance Maximum $(S_{pri} / S_{lim_pri} + (S_{sec} / S_{lin_Sec}) < 1$
1	Bluetooth	2441	0.0034	0.4004	Compliant
	TOBY R202	FDD 2	0.3969		
2	Bluetooth	2441	0.0034	0.5076	Compliant
	TOBY R202	FDD 5	0.5042		
3	WLAN	2437	0.0924	0.4893	Compliant
	TOBY R202	FDD 2	0.3969		
4	WLAN	2437	0.0924	0.5966	Compliant
	TOBY R202	FDD 5	0.5042		
5	Bluetooth	2441	0.0019	0.4912	Compliant
	WLAN	2437	0.0924		
	TOBY R202	FDD 2	0.3969		
6	Bluetooth	2441	0.0019	0.5984	Compliant
	WLAN	2437	0.0924		
	TOBY R202	FDD 5	0.5042		
10	Bluetooth	2441	0.0019	0.3100	Compliant
	TOBY R202	eFDD4	0.3081		
11	WLAN	2437	0.0924	0.4005	Compliant
	TOBY R202	eFDD4	0.3081		
12	Bluetooth	2441	0.0019	0.3600	Compliant
	WLAN	2437	0.0500		
	TOBY R202	eFDD4	0.3081		
13	Bluetooth	2441	0.0019	0.9036	Compliant
	TOBY R202	eFDD 12	0.9018		
14	WLAN	2437	0.0019	0.9036	Compliant
	TOBY R202	eFDD 12	0.9018		
15	Bluetooth	2441	0.0019	0.9960	Compliant
	WLAN	2437	0.0924		
	TOBY R202	eFDD 12	0.9018		
16	Bluetooth	2441	0.0034	0.8908	Compliant
	TOBY R202	eFDD 5	0.8874		
17	Bluetooth	2441	0.0034	0.6622	Compliant
	TOBY R202	eFDD 2	0.6588		
18	WLAN	2437	0.0924	0.9797	Compliant
	TOBY R202	eFDD 5	0.8874		
19	WLAN	2437	0.0924	0.7511	Compliant
	TOBY R202	eFDD 2	0.6588		
20	Bluetooth	2441	0.0034	0.9832	Compliant
	WLAN	2437	0.0924		
	TOBY R202	eFDD 5	0.8874		
21	Bluetooth	2441	0.0034	0.7546	Compliant
	WLAN	2437	0.0924		
	TOBY R202	eFDD 2	0.6588		

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}	Maximum $S_{pri} / S_{lim_pri} + S_{sec} / S_{lin_Sec}$	Compliance Maximum $(S_{pri} / S_{lim_pri} + (S_{sec} / S_{lin_Sec}) < 1$
1	Bluetooth	2441	0.0034	0.8718	Compliant
	TOBY R202	FDD 2	0.8684		
2	Bluetooth	2441	0.0034	0.9020	Compliant
	TOBY R202	FDD 5	0.8986		
3	WLAN	2437	0.0924	0.9608	Compliant
	TOBY R202	FDD 2	0.8684		
4	WLAN	2437	0.0924	0.9910	Compliant
	TOBY R202	FDD 5	0.8986		
5	Bluetooth	2441	0.0034	0.9642	Compliant
	WLAN	2437	0.0924		
	TOBY R202	FDD 2	0.8684		
6	Bluetooth	2441	0.0034	0.9944	Compliant
	WLAN	2437	0.0924		
	TOBY R202	FDD 5	0.8986		
10	Bluetooth	2441	0.0034	0.7234	Compliant
	TOBY R202	eFDD4	0.7199		
11	WLAN	2437	0.0924	0.8123	Compliant
	TOBY R202	eFDD4	0.7199		
12	Bluetooth	2441	0.0034	0.8157	Compliant
	WLAN	2437	0.0924		
	TOBY R202	eFDD4	0.7199		
13	Bluetooth	2441	0.0034	0.9011	Compliant
	TOBY R202	eFDD 12	0.8976		
14	WLAN	2437	0.0924	0.9900	Compliant
	TOBY R202	eFDD 12	0.8976		
15	Bluetooth	2441	0.0034	0.9934	Compliant
	WLAN	2437	0.0924		
	TOBY R202	eFDD 12	0.8976		
16	Bluetooth	2441	0.0034	0.8892	Compliant
	TOBY R202	eFDD 5	0.8857		
17	Bluetooth	2441	0.0034	0.8937	Compliant
	TOBY R202	eFDD 2	0.8902		
18	WLAN	2437	0.0924	0.9781	Compliant
	TOBY R202	eFDD 5	0.8857		
19	WLAN	2437	0.0924	0.9826	Compliant
	TOBY R202	eFDD 2	0.8902		
20	Bluetooth	2441	0.0034	0.9816	Compliant
	WLAN	2437	0.0924		
	TOBY R202	eFDD 5	0.8857		
21	Bluetooth	2441	0.0034	0.9860	Compliant
	WLAN	2437	0.0924		
	TOBY R202	eFDD 2	0.8902		

When operating the primary transmitter simultaneously with a generic Bluetooth and WLAN radio, the following antenna gains can be used with the module TOBY-R202 while still complying with the exposure limits.

Band	dBi (For FCC)	dBi (For Industry Canada)
FDD 2	8.5	8.5
FDD 5	7	6.2
eFDD 5	9.9	6.6
eFDD 2	11.2	9.1
eFDD 4	7.9	7.9
eFDD 12	9.3	6.2