

InterLab[®]

RF Exposure and Maximum ERP/EIRP Assessment

For

TOBY-L201
FCC ID: XPYTOBYL201
IC: 8595A-TOBYL201

Assessment Reference: MDE_UBLOX_1807_L201_MPEc

Test Laboratory:

7layers GmbH
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40880 Ratingen
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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 GSM/UMTS/LTE radio module. Including RF Exposure for use with co-located radios on generic host device.

Applicable FCC and IC 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, July 2015

Report version control			
Rev Version	Release date	Changes	Version validity
MPEc	2019.02.26	Initial version	Valid

Responsible for
Accreditation Scope*:



Responsible
for Report:



*ERP/EIRP Measurement

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 IC and accepted under the registration number 96716 and IC 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: 29-02-2017

1.2 Project Data

Responsible for assessment and report: Mr. Sören Berentzen

Date of Report: 26-02-2019

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: please see applicant data

Contact Person: please see applicant data

2 Test object Data

2.1 General EUT Description

Equipment under Test	UMTS/LTE Voice/Data Module
Type Designation:	TOBY-L201
Kind of Device:	UMTS/LTE Voice/Data Module
GSM MSC/UMTS/LTE CAT	- / 12 / 4
FCC ID:	XPYTOBYL201
IC Number:	8595A-TOBYL201

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: DE1015014aa01)	UMTS/LTE Module	TOBY-L201	358502060012807	218A02	V09.81
EUT B (Code: DE1015014aa03)	UMTS/LTE Module	TOBY-L201	358502064213286	218B01	V16.16
EUT D (Code: DE1015014ae02)	UMTS/LTE Module	TOBY-L201	358502060012930	218A02	V09.82
EUT E (Code: DE1015014ba04)	UMTS/LTE Module	TOBY-L201	358502060016972	218A03	V09.84
Remark: EUT A, EUT B, EUT D and EUT E are equipped with a temporary antenna connector. The Modules are not sold with a predefined antenna.					

NOTE: EUT A, EUT D and EUT E have been used for all supported frequency bands except eFDD4 and eFDD17. EUT B has been used for frequency band eFDD4 and eFDD17 only.

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	FDD4,13,17 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 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 (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Freq of highest power	FCC EIRP limit (mW)	Maximum antenna gain to meet EIRP Limit (dBi)
FDD 2	UMTS	100.0%	1850 - 1907.6	24.5	281.83829	1907.60	2000	8.5
FDD 5	UMTS	100.0%	824 - 846.6	24.5	281.83829	836.00	11484	16.1
eFDD 2	LTE	100.0%	1850-1910	22.58	181.13401	1902.50	2000	10.4
eFDD 4	LTE	100.0%	1710-1755	22.89	194.53601	1710.00	1000	7.1
eFDD 5	LTE	100.0%	824 - 849	22.99	199.06733	825.50	11484	17.6
eFDD13	LTE	100.0%	777-787	22.25	167.8804	784.50	3000	12.5
eFDD 17	LTE	100.0%	704-716	22.71	186.63797	704.00	3000	12.1

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
FDD 2	8.5	12.5	9.1	8.5
FDD 5	16.1	10.0	6.7	6.7
eFDD 2	10.4	13.0	9.6	9.6
eFDD 4	7.1	13.0	9.3	7.1
eFDD 5	17.6	10.4	7.1	7.1
eFDD13	12.5	10.2	7.0	7.0
eFDD 17	12.1	9.7	6.7	6.7

The above table lists the gains which conform to both the EIRP limits and the MPE limits for both IC 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)
FDD 2	UMTS	100%	1907.6	24.5	281.84	281.84	0.4571	9.1	20
FDD 5	UMTS	100%	836.0	24.5	281.84	281.84	0.2601	6.7	20
eFDD 2	LTE	100%	1902.5	24.0	251.19	251.19	0.4563	9.6	20
eFDD 4	LTE	100%	1710.0	24.0	251.19	251.19	0.4242	9.3	20
eFDD 5	LTE	100%	825.5	24.0	251.19	251.19	0.2579	7.1	20
eFDD13	LTE	100%	784.5	24.0	251.19	251.19	0.2491	7.0	20
eFDD 17	LTE	100%	704.0	24.0	251.19	251.19	0.2313	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)
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%	1710.0	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
eFDD13	LTE	100.0%	777.0	24	251.19	251.19	0.5230	10.2	20
eFDD 17	LTE	100.0%	704.0	24	251.19	251.19	0.4693	9.7	20

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

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	10.2	7.0	7.0
eFDD 17	9.7	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
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.

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

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.
6. Where the maximum allowable gain permitted with respect to EIRP is lower than the maximum allowable gain for relative exposure, the lower gain respecting the EIRP limit shall be used to make the calculation.

3.3.3 Test Protocol

The below table is to determine the MPE values using the maximum gain values obtained in below.

OP mode-1 – FOR FCC ONLY

Band	Mode	Duty Cycle (%)	Frequency (MHZ)	Maximum Conducted output power (dBm)	Max Conducted output power (mW)	FCC MPE Limit (mW/cm ²)	Power Density (mW/cm ²)	Separation distance (cm)	Verdict
FDD 2	UMTS	100%	1907.6	24.5	281.84	1.0000	0.3979	20	Pass
FDD 5	UMTS	100%	836.0	24.5	281.84	0.5573	0.5233	20	Pass
eFDD 2	LTE	100%	1902.5	24	251.19	1.0000	0.5518	20	Pass
eFDD 4	LTE	100%	1710.0	24	251.19	1.0000	0.2569	20	Pass
eFDD 5	LTE	100%	825.5	24	251.19	0.5503	0.5114	20	Pass
eFDD13	LTE	100%	784.5	24	251.19	0.5230	0.4883	20	Pass
eFDD 17	LTE	100%	704.0	24	251.19	0.4693	0.4352	20	Pass

OP mode-1 – FOR Industry Canada ONLY

Band	Mode	Duty Cycle (%)	Frequency (MHZ)	Maximum Conducted output power (dBm)	Max Conducted output power (mW)	FCC MPE Limit (mW/cm ²)	Power Density (mW/cm ²)	Separation distance (cm)	Verdict
FDD 2	UMTS	100%	1907.6	24.5	281.84	0.4571	0.3979	20	Pass
FDD 5	UMTS	100%	836.0	24.5	281.84	0.2601	0.2337	20	Pass
eFDD 2	LTE	100%	1902.5	24	251.19	0.4563	0.4062	20	Pass
eFDD 4	LTE	100%	1710.0	24	251.19	0.4242	0.2569	20	Pass
eFDD 5	LTE	100%	825.5	24	251.19	0.2579	0.2284	20	Pass
eFDD13	LTE	100%	784.5	24	251.19	0.2491	0.2232	20	Pass
eFDD 17	LTE	100%	704.0	24	251.19	0.2313	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	Freq (MHz)	Duty Cycle	ERP (mW)	ERP Equivalent (mW)	MPE Limit (mW/cm ²)	Maximum antenna gain	Power density	Separation distance (cm)	Verdict
Bluetooth	2441	64%	8.91	3.72	1.0000	4.0	0.0019	20	Pass
WLAN	2412	100%	79.43	79.43	1.0000	5.0	0.0500	20	Pass

MPE Calculation for Single Transmitter installed in Generic host for IC

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.

Relative exposure for Primary Transmitter for FCC

OP-Mode	Mode	Output Power	Frequency (MHZ)	Seq	Slin (mW/cm ²)	<u>Seq</u> ----- <u>Slin</u>	Verdict
FDD 2	UMTS	281.8383	1907.6	0.3979	1.0000	0.3978877	Pass
FDD 5	UMTS	281.8383	836.0	0.5233	0.5573	0.9388917	Pass
eFDD 2	LTE	251.1886	1902.5	0.5518	1.0000	0.5517731	Pass
eFDD 4	LTE	251.1886	1710.0	0.2569	1.0000	0.2568801	Pass
eFDD 5	LTE	251.1886	825.5	0.5114	0.5503	0.9291904	Pass
eFDD13	LTE	251.1886	784.5	0.4883	0.5230	0.9337461	Pass
eFDD 17	LTE	251.1886	704.0	0.4352	0.4693	0.9273616	Pass

Relative exposure for Primary Transmitter for IC							
OP-Mode	Mode	Output Power	Frequency (MHZ)	Seq	Slin (mW/cm ²)	<u>Seq</u> ----- <u>SLin</u>	Verdict
FDD 2	UMTS	281.8383	1907.6	0.3979	0.4571	0.8704423	Pass
FDD 5	UMTS	281.8383	836.0	0.2337	0.2601	0.8985852	Pass
eFDD 2	LTE	251.1886	1902.5	0.4062	0.4563	0.8902347	Pass
eFDD 4	LTE	251.1886	1710.0	0.2569	0.4242	0.6055716	Pass
eFDD 5	LTE	251.1886	825.5	0.2284	0.2579	0.8857488	Pass
eFDD13	LTE	251.1886	784.5	0.2232	0.2491	0.8962521	Pass
eFDD 17	LTE	251.1886	704.0	0.2083	0.2313	0.9006662	Pass

Relative exposure for Secondary transmitter FCC				
Transmitter	Output power	Seq	Slin (mW/cm ²)	<u>Seq</u> ----- <u>SLin</u>
Bluetooth	3.72	0.0019	1.0000	0.0019
WLAN	79.43	0.0500	1.0000	0.0500

Relative exposure for Secondary transmitter IC				
Transmitter	Output power	Seq	Slin (mW/cm ²)	<u>Seq</u> ----- <u>SLin</u>
Bluetooth	3.72	0.0019	0.5410	0.0034319
WLAN	79.43	0.0500	0.5410	0.0923701

Simultaneous exposure of Primary and Secondary transmitter installed in generic host device for FCC						
Primary Band	Primary Mode	All Transmitters	Frequency (MHZ)	Maximum Seq / SLin	Maximum Spri/Slin_pri + Ssec / Slin_Sec	Compliance Maximum (Spri/Slin_pri) + (Ssec / Slin_Sec) < 1
FDD 2	UMTS	Bluetooth	2441	0.0019	0.4497	Compliant
		Wlan	2412	0.0500		
		TOBY-L201	1907.6	0.3979		
FDD 5	UMTS	Bluetooth	2441	0.0019	0.9907	Compliant
		Wlan	2412	0.0500		
		TOBY-L201	836.0	0.9389		
eFDD 2	LTE	Bluetooth	2441	0.0019	0.6036	Compliant
		Wlan	2412	0.0500		
		TOBY-L201	1902.5	0.5518		

eFDD 4	LTE	Bluetooth	2441	0.0019	0.3087	Compliant
		Wlan	2412	0.0500		
		TOBY-L201	1710.0	0.2569		
eFDD 5	LTE	Bluetooth	2441	0.0019	0.9810	Compliant
		Wlan	2412	0.0500		
		TOBY-L201	825.5	0.9292		
eFDD13	LTE	Bluetooth	2441	0.0019	0.9856	Compliant
		Wlan	2412	0.0500		
		TOBY-L201	784.5	0.9337		
eFDD 17	LTE	Bluetooth	2441	0.0019	0.9792	Compliant
		Wlan	2412	0.0500		
		TOBY-L201	704.0	0.9316		

Simultaneous exposure of Primary and Secondary transmitter installed in generic host device for IC						
Primary Band	Primary Mode	Transmitter	Frequency (MHZ)	Maximum Seq / Slin	Maximum Spri/Slim_pri + Ssec / Slin_Sec	Compliance Maximum (Spri/Slim_pri) + (Ssec / Slin_Sec) < 1
FDD 2	UMTS	Bluetooth	2441	0.0034	0.9662	Compliant
		Wlan	2412	0.0924		
		TOBY-L201	1907.6	0.8704		
FDD 5	UMTS	Bluetooth	2441	0.0034	0.9944	Compliant
		Wlan	2412	0.0924		
		TOBY-L201	836	0.8986		
eFDD 2	LTE	Bluetooth	2441	0.0034	0.9860	Compliant
		Wlan	2412	0.0924		
		TOBY-L201	1902.5	0.8902		
eFDD 4	LTE	Bluetooth	2441	0.0034	0.7014	Compliant
		Wlan	2412	0.0924		
		TOBY-L201	1710	0.6056		
eFDD 5	LTE	Bluetooth	2441	0.0034	0.9816	Compliant
		Wlan	2412	0.0924		
		TOBY-L201	825.5	0.8857		
eFDD13	LTE	Bluetooth	2441	0.0034	0.9921	Compliant
		Wlan	2412	0.0924		
		TOBY-L201	784.5	0.8963		
eFDD 17	LTE	Bluetooth	2441	0.0034	0.9965	Compliant
		Wlan	2412	0.0924		
		TOBY-L201	704	0.8842		

When operating the primary transmitter simultaneously with a generic Bluetooth and WLAN radio, the following antenna gains can be used with the module TOBY-L201 while still complying with the exposure limits.

OP-Mode	dBi (For FCC)	dBi (For Industry Canada)
FDD 2	8.5	8.5
FDD 5	9.7	6.2
eFDD 2	10.4	9.1
eFDD 4	7.1	7.1
eFDD 5	10.1	6.6
eFDD13	9.9	6.5
eFDD 17	9.4	6.2