

InterLab[®]

RF Exposure and Maximum ERP/EIRP Assessment

For

TOBY-L280
FCC ID: XPYTOBYL280
IC: 8595A-TOBYL280

Assessment Reference: MDE_UBLOX_1807_L280_MPEg

Test Laboratory:

7layers GmbH
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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.

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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 and IC Rules

For RF Exposure:

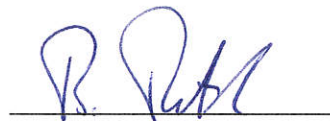
OET Bulletin 65 Edition 97-01 August 1997
FCC 47 CFR §1.1307
FCC 47 CFR §1.1310
RSS-102 Issue 5 – March 2015

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
MPEg	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: 08-02-2017

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	GSM/UMTS /LTE Voice/Data Module
Type Designation:	TOBY-L280
Kind of Device:	GSM/UMTS/LTE Voice/Data Module
GSM MSC/UMTS/LTE CAT	33 / 12 / 4
FCC ID:	FCC ID: XPTYOBYL280
IC Number:	IC: 8595A-TOBYL280

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 B (Code: DE1015015ab01)	GSM/UMTS/LTE Module	TOBY-L280	358503060599298	217B00	V16.16
EUT A (Code: DE1015016aa01)	UMTS/LTE Module	TOBY-L280	358503060011765	217001	09.90
EUT D (Code: DE1015016ag01)	UMTS/LTE Module	TOBY-L280	358503060012011	217001	09.90
Remark: EUT A, B and D are equipped with a temporary antenna connector. The Modules are not sold with a predefined antenna.					

NOTE: EUT A and EUT D have been used for all supported frequency bands except FDD5, eFDD5 and eFDD7. EUT B has been used for frequency band FDD5, eFDD5 and eFDD7 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	(850MHz GSM/GPRS) (FDD5 WCDMA/HSUPA/HSDPA/LTE)
FCC 47 CFR §24.232 IC RSS-133 Issue 6	(1900MHz GSM/GPRS) (FDD2 WCDMA/HSUPA/HSDPA)
FCC 47 CFR §27.50(d) RSS-139, Issue 2 / SRSP-513	(FDD7 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)
850	GSM	50.0%	836.2 - 848.8	32.42	1745.8222	848.80	11484	8.2
1900	GSM	50.0%	1850.2 - 1909.8	29.63	918.3326	1909.80	2000	3.4
FDD 2	UMTS	100.0%	1850 - 1907.6	22.46	176.1976	1881.40	2000	10.6
FDD 5	UMTS	100.0%	824 - 846.6	22.54	179.47336	836.00	11484	18.1
eFDD 5	LTE	100.0%	824 - 849	23.21	209.41125	836.00	11484	17.4
eFDD 7	LTE	100.0%	2500-2570	21.93	155.95525	2535.00	1000	8.1

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
850	8.2	4.3	1.0	1.0
1900	3.4	9.8	6.4	3.4
FDD 2	10.6	12.5	9.1	9.1
FDD 5	18.1	10.0	6.7	6.7
eFDD 5	17.4	10.5	7.2	7.2
eFDD 7	8.1	13.0	10.5	8.1

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)
850	GSM	50%	848.8	33.3	2113.49	1056.82	0.2628	1.0	20
1900	GSM	50%	1909.8	30.2	1047.13	523.60	0.4575	6.4	20
FDD 2	UMTS	100%	1881.4	24.5	281.84	281.84	0.4528	9.1	20
FDD 5	UMTS	100%	836.0	24.5	281.84	281.84	0.2601	6.7	20
eFDD 5	LTE	100%	836.0	24.0	251.19	251.19	0.2601	7.2	20
eFDD 7	LTE	100%	2535.0	24.0	251.19	251.19	0.5552	10.5	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	50%	848.8	33.25	2113.49	1056.82	0.5659	4.3	20
1900	GSM	50%	1909.8	30.2	1047.13	523.60	1.0000	9.8	20
FDD 2	UMTS	100.0%	1881.4	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 5	LTE	100.0%	836.0	24	251.19	251.19	0.5573	10.5	20
eFDD 7	LTE	100.0%	2535.0	24	251.19	251.19	1.0000	13.0	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
850	4.3	1.0	1.0
1900	9.8	6.4	6.4
FDD 2	12.5	9.1	9.1
FDD 5	10.0	6.7	6.7
eFDD 5	10.5	7.2	7.2
eFDD 7	13.0	10.5	10.5

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.

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

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 $\geq 20\text{cm}$.
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
850	GSM	50%	848.8	33.25	1056.82	0.5659	0.5282	20	Pass
1900	GSM	50%	1909.8	30.2	523.60	1.0000	0.2269	20	Pass
FDD 2	UMTS	100%	1881.4	24.5	281.84	1.0000	0.6364	20	Pass
FDD 5	UMTS	100%	836.0	24.5	281.84	0.5573	0.5234	20	Pass
eFDD 5	LTE	100%	836.0	24	251.19	0.5573	0.5234	20	Pass
eFDD 7	LTE	100%	2535.0	24	251.19	1.0000	0.3204	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
850	GSM	50%	848.8	33.25	1056.82	0.2628	0.2360	20	Pass
1900	GSM	50%	1909.8	30.2	523.60	0.4575	0.2269	20	Pass
FDD 2	UMTS	100%	1881.4	24.5	281.84	0.4528	0.4072	20	Pass
FDD 5	UMTS	100%	836.0	24.5	281.84	0.2601	0.2338	20	Pass
eFDD 5	LTE	100%	836.0	24	251.19	0.2601	0.2338	20	Pass
eFDD 7	LTE	100%	2535.0	24	251.19	0.5552	0.3204	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
850	GSM	1056.8175	848.8	0.5282	0.5659	0.9334898	Pass
1900	GSM	523.6004	1909.8	0.2269	1.0000	0.2268613	Pass
FDD 2	UMTS	281.8383	1881.4	0.6364	1.0000	0.6364445	Pass
FDD 5	UMTS	281.8383	836.0	0.5234	0.5573	0.9390932	Pass
eFDD 5	LTE	251.1886	836.0	0.5234	0.5573	0.9390932	Pass
eFDD 7	LTE	251.1886	2535.0	0.3204	1.0000	0.320428	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
850	GSM	1056.8175	848.8	0.2360	0.2628	0.8977235	Pass
1900	GSM	523.6004	1909.8	0.2269	0.4575	0.4959043	Pass
FDD 2	UMTS	281.8383	1881.4	0.4072	0.4528	0.8991758	Pass
FDD 5	UMTS	281.8383	836.0	0.2338	0.2601	0.898778	Pass
eFDD 5	LTE	251.1886	836.0	0.2338	0.2601	0.898778	Pass
eFDD 7	LTE	251.1886	2535.0	0.3204	0.5552	0.5771869	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/Slim_pri + Ssec / Slin_Sec	Compliance Maximum (Spri/Slim_pri) + (Ssec / Slin_Sec) < 1
850	GSM	Bluetooth	2441	0.0019	0.9853	Compliant
		Wlan	2412	0.0500		
		TOBY-L280	848.8	0.9335		
1900	GSM	Bluetooth	2441	0.0019	0.2787	Compliant
		Wlan	2412	0.0500		
		TOBY-L280	1909.8	0.2269		
FDD 2	UMTS	Bluetooth	2441	0.0019	0.6883	Compliant
		Wlan	2412	0.0500		
		TOBY-L280	1881.4	0.6364		
FDD 5	UMTS	Bluetooth	2441	0.0019	0.9909	Compliant
		Wlan	2412	0.0500		
		TOBY-L280	836.0	0.9391		
eFDD 5	LTE	Bluetooth	2441	0.0019	0.9909	Compliant
		Wlan	2412	0.0500		
		TOBY-L280	836.0	0.9391		
eFDD 7	LTE	Bluetooth	2441	0.0019	0.3723	Compliant
		Wlan	2412	0.0500		
		TOBY-L280	2535.0	0.3204		

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
850	GSM	Bluetooth	2441	0.0034	0.9935	Compliant
		Wlan	2412	0.0924		
		TOBY-L280	848.8	0.8977		
1900	GSM	Bluetooth	2441	0.0034	0.5917	Compliant
		Wlan	2412	0.0924		
		TOBY-L280	1909.8	0.4959		
FDD 2	UMTS	Bluetooth	2441	0.0034	0.9950	Compliant
		Wlan	2412	0.0924		
		TOBY-L280	1881.4	0.8992		
FDD 5	UMTS	Bluetooth	2441	0.0034	0.9946	Compliant
		Wlan	2412	0.0924		

		TOBY-L280	836	0.8988		
eFDD 5	LTE	Bluetooth	2441	0.0034	0.9946	Compliant
		Wlan	2412	0.0924		
		TOBY-L280	836	0.8988		
		Bluetooth	2441	0.0034		
eFDD 7	LTE	Wlan	2412	0.0924	0.6730	Compliant
		TOBY-L280	2535	0.5772		
		Bluetooth	2441	0.0034		
		Wlan	2412	0.0924		

When operating the primary transmitter simultaneously with a generic Bluetooth and WLAN radio, the following antenna gains can be used with the module TOBY-L280 while still complying with the exposure limits.

OP-Mode	dBi (For FCC)	dBi (For Industry Canada)
850	4.0	0.5
1900	3.4	3.4
FDD 2	10.6	8.6
FDD 5	9.7	6.2
eFDD 5	10.2	6.7
eFDD 7	8.1	8.1