

InterLab®

RF Exposure and Maximum ERP/EIRP Assessment

For

TOBY-L200 GSM/UMTS Module

FCC ID: XPYTOBYL200

IC: 8595A-TOBYL200

Assessment Reference: MDE_UBLOX_1408_MPEa Rev 3

Test Laboratory:

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40880 Ratingen



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 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 4 – March 2010

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	24.09.2014	Initial version	Not Valid
002	20.10.2014	Applied tune-up values to ERP/EIRP	Not Valid
003	22.10.2014	Added additional information to page 7	Valid

Responsible for
Accreditation Scope:



Responsible
for Report:



1 Administrative Data

1.1 Testing Laboratory

Company Name: 7Layers AG

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: 2014-05-15

1.2 Project Data

Responsible for assessment and report: Mr. Patrick Lomax

Date of Report: 2014-09-23

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	TOBY-L200 Module
Type Designation:	TOBY-L200
Kind of Device: GPRS/EDGE MSC	GSM/UMTS/LTE Data Module
GPRS Multi-slot class	12
FCC ID:	XPYTOBYL200
IC Number:	8595A-TOBYL200

General product description:

The EUT is Cellular radio module supporting GSM/GPRS/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: DE1015003AU12	TOBY-L200	L200	352255060018284	192BA0	09.41

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
N/A						-

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						-

2.5 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

Op. Mode	Description of Operating Modes	Remarks
Op-mode 1	EUT transmitting in standalone configuration	Antenna-to-person distance > 20cm
Op-mode 2	EUT transmitting in the 850 MHz Band simultaneously with a generic Bluetooth radio.	Antenna-to-person distance > 20cm
Op-mode 3	EUT transmitting in the 1900 MHz Band simultaneously with a generic Bluetooth radio.	Antenna-to-person distance > 20cm
Op-mode 4	EUT transmitting in the 850 MHz Band simultaneously with a generic WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 5	EUT transmitting in the 1900 MHz Band simultaneously with a generic WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 6	EUT transmitting in the 850 MHz Band simultaneously with a generic Bluetooth radio and WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 7	EUT transmitting in the 1900 MHz Band simultaneously with a generic Bluetooth radio and WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 8	EUT transmitting in the 700 MHz Band simultaneously with a generic Bluetooth radio.	Antenna-to-person distance > 20cm
Op-mode 9	EUT transmitting in the 700 MHz Band simultaneously with a generic WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 10	EUT transmitting in the 700 MHz Band simultaneously with a generic Bluetooth radio and WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 11	EUT transmitting in the 1700 MHz Band simultaneously with a generic Bluetooth radio.	Antenna-to-person distance > 20cm
Op-mode 12	EUT transmitting in the 1700 MHz Band simultaneously with a generic WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 13	EUT transmitting in the 1700 MHz Band simultaneously with a generic Bluetooth radio and WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 14	EUT transmitting in the 2500 MHz Band simultaneously with a generic Bluetooth radio.	Antenna-to-person distance > 20cm
Op-mode 15	EUT transmitting in the 2500 MHz Band simultaneously with a generic WLAN radio.	Antenna-to-person distance > 20cm
Op-mode 16	EUT transmitting in the 2500 MHz Band simultaneously with a generic Bluetooth radio and WLAN radio.	Antenna-to-person distance > 20cm

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/LTE)
FCC 47 CFR §27.50(d) RSS-139, Issue 2 / SRSP-513	(FDD4,7,17 UMTS/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	FCC / IC EIRP limit (mW)	Maximum antenna gain to meet EIRP Limit (dBi)
850	GSM	50.0%	836.2 - 848.8	33.25	2113.48904	848.80	11484	7.4
1900	GSM	50.0%	1850.2 - 1909.8	30.2	1047.128548	1909.80	2000	2.8
FDD 2	UMTS	100.0%	1850 - 1907.6	24.5	281.8382931	1907.60	2000	8.5
FDD 4	UMTS	100.0%	1710 - 1752.6	24.5	281.8382931	1740.00	1000	5.5
FDD 5	UMTS	100.0%	824 - 846.6	24.5	281.8382931	836.00	11484	16.1
eFDD 2	LTE	100.0%	1850-1910	24	251.1886432	1908.00	2000	9.0
eFDD 4	LTE	100.0%	1710-1755	24	251.1886432	1732.50	1000	6.0
eFDD 5	LTE	100.0%	824 - 849	24	251.1886432	826.50	11484	16.6
eFDD 7	LTE	100.0%	2500-2570	24	251.1886432	2535.00	1000	6.0
eFDD 17	LTE	100.0%	704-716	24	251.1886432	710.00	4920	12.8

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 MPE Limits	Maximum gain to be compliant with all limits
	FDD17	10.8	9.8	9.8
	GSM 850	7.4	4.3	4.3
	GSM 1900	2.8	9.8	2.8
	FDD 4	5.5	5.5	5.5
	FDD 7	6.0	13.0	6.0

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 4 – March 2010

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

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 FCC and 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 / GPRS	50%	848.8	33.25	2113.49	1056.82	0.5659	4.3	20
1900	GSM / GPRS	50%	1909.8	30.2	1047.13	523.60	1.0000	9.8	20
FDD 2	UMTS	100.0%	1907.6	24.5	281.84	281.84	1.0000	12.5	20
FDD 4	UMTS	100.0%	1740.0	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%	1908.0	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%	826.5	24	251.19	251.19	0.5510	10.4	20
eFDD 7	LTE	100.0%	2535.0	24	251.19	251.19	1.0000	13.0	20
eFDD 17	LTE	100.0%	710.0	24	251.19	251.19	0.4733	9.8	20

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

3.2.3 Conclusion

Maximum antenna gain for MPE compliance	Frequency Band	Maximum gain to be used for MPE Compliance
	700 MHz	9.8
	850 MHz	4.3
	1900 MHz	9.8
	1700 MHz	12.5
	2500 MHz	13.0

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 4 – March 2010

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 is ≥ 20 cm.
3. Separation distance between co-located transmitting antennas is 0cm.
4. Hypothetical Bluetooth radio is assumed to have an EIRP of 100mW.
5. Hypothetical WLAN radio is assumed to have an EIRP of 2000mW.

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

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
850	GSM / GPRS	50%	848.8	33.25	1056.82	0.5659	0.3182	20	Pass
1900	GSM / GPRS	50%	1909.8	30.2	523.60	1.0000	0.5858	20	Pass
FDD 2	UMTS	100.0%	1907.6	24.5	281.84	1.0000	0.0849	20	Pass
FDD 4	UMTS	100.0%	1740.0	24.5	281.84	1.0000	0.5738	20	Pass
FDD 5	UMTS	100.0%	836.0	24.5	281.84	0.5573	0.0849	20	Pass
eFDD 2	LTE	100.0%	1908.0	24	251.19	1.0000	0.2810	20	Pass
eFDD 4	LTE	100.0%	1732.5	24	251.19	1.0000	0.5114	20	Pass
eFDD 5	LTE	100.0%	826.5	24	251.19	0.5510	0.0756	20	Pass
eFDD 7	LTE	100.0%	2535.0	24	251.19	1.0000	0.5738	20	Pass
eFDD 17	LTE	100.0%	710.0	24	251.19	0.4733	0.1773	20	Pass

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

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								
Radio type	Duty Cycle	EIRP (mW)	EIRP Equivalent (mW)	MPE Limit (mW/cm ²)	Maximum antenna gain (dBi)	Power density (mW/cm ²)	Separation distance (cm)	Verdict
Bluetooth	25%	100.00	76.43	1.0000	0.0	0.0152	20	Pass
WLAN	100%	2000.00	2000.00	1.0000	0.0	0.3979	20	Pass

OP mode-1

Relative exposure for Primary Transmitter							
OP-Mode	Mode	EIRP	Frequency (MHZ)	S_{eq}	S_{lin} (mW/cm ²)	S_{eq} ----- S_{lin}	Verdict
850	GSM / GPRS	1330.4544	848.8	0.3182	0.5659	0.56236256	Pass
1900	GSM / GPRS	659.1739	1909.8	0.5858	1.0000	0.58577457	Pass
FDD 2	UMTS	354.8134	1907.6	0.3153	1.0000	0.31530475	Pass
FDD 4	UMTS	354.8134	1740.0	0.5738	1.0000	0.57376032	Pass
FDD 5	UMTS	354.8134	836.0	0.0849	0.5573	0.1522704	Pass
eFDD 2	LTE	316.2278	1908.0	0.2810	1.0000	0.28101565	Pass
eFDD 4	LTE	316.2278	1732.5	0.5047	1.0000	0.50472159	Pass
eFDD 5	LTE	316.2278	826.5	0.0756	0.5510	0.13727104	Pass
eFDD 7	LTE	316.2278	2535.0	0.5738	1.0000	0.57376032	Pass
eFDD 17	LTE	316.2278	710.0	0.2748	0.4733	0.58066562	Pass

Relative exposure for Secondary transmitter					
OP-Mode	Transmitter	EIRP	S_{eq} (mW/cm ²)	S_{lin} (mW/cm ²)	S_{eq} ----- S_{lin}
2	Bluetooth	76.43	0.0152	1.0000	0.015205278
3	WLAN	2000.00	0.3979	1.0000	0.397887694
4	Bluetooth	76.43	0.0152	1.0000	0.015205278
	WLAN	2000.00	0.3979	1.0000	0.397887694

Simultaneous exposure or Primary and Secondary transmitter installed in generic host device with Bluetooth and WLAN					
OP-Mode	Transmitter	Frequency (MHZ)	Maximum S_{eq} / S_{Lin}	Maximum $S_{pri} / S_{lim_pri} + S_{sec} / S_{lin_Sec}$	Compliance Maximum $(S_{pri} / S_{lim_pri}) + (S_{sec} / S_{lin_Sec}) < 1$
2	Bluetooth	2441	0.0152	0.5776	Compliant
	TOBY L200	850	0.5624		
3	Bluetooth	2441	0.0152	0.6010	Compliant
	TOBY L200	1900	0.5858		
4	WLAN	2437	0.3979	0.9603	Compliant
	TOBY L200	850	0.5624		
5	WLAN	2437	0.3979	0.9837	Compliant
	TOBY L200	1900	0.5858		
6	Bluetooth	2441	0.0152	0.9755	Compliant
	WLAN	2437	0.3979		
	TOBY L200	850	0.5624		
7	Bluetooth	2441	0.0152	0.9989	Compliant
	WLAN	2437	0.3979		
	TOBY L200	1900	0.5858		
8	Bluetooth	2441	0.0152	0.5959	Compliant
	TOBY L200	700	0.5807		
9	WLAN	2437	0.3979	0.9786	Compliant
	TOBY L200	700	0.5807		
10	Bluetooth	2441	0.0152	0.9938	Compliant
	WLAN	2437	0.3979		
	TOBY L200	700	0.5807		
11	Bluetooth	2441	0.0152	0.5890	Compliant
	TOBY L200	1700	0.5738		
12	WLAN	2437	0.3979	0.9716	Compliant
	TOBY L200	1700	0.5738		
13	Bluetooth	2441	0.0152	0.9869	Compliant
	WLAN	2437	0.3979		
	TOBY L200	1700	0.5738		
14	Bluetooth	2441	0.0152	0.5890	Compliant
	TOBY L200	2500	0.5738		
15	WLAN	2437	0.0152	0.5890	Compliant
	TOBY L200	2500	0.5738		
16	Bluetooth	2441	0.0152	0.9869	Compliant
	WLAN	2437	0.3979		
	TOBY L200	2500	0.5738		

3.3.4 Conclusion

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

Band	dBi
700	5.5
850	1.8
1700	10.1
1900	7.5
2500	10.6