



Radio Frequency Exposure Evaluation Report

FOR:

u-blox AG

Model Name:

SARA-R412M

Product Description:

Cellular Module

FCC ID: XPYUBX18ZO01

IC ID: 8595A-UBX18ZO01

Applied Rules and Standards:

CFR Part 1 (1.1307 & 1.1310), Part 2 (2.1091),
ISED RSS-102 Issue 5

Report number: EMC_CTSMC-003-18001_FCC_ISED_MPE_Rev_1

DATE: 2019-1-24



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3462B-1

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1. Assessment

This RF Exposure evaluation report provides information about compliance of the below identified device with the RF Exposure limits for mobile devices as defined in FCC CFR Part 1 (1.1307 & 1.1310), Part 2 (2.1091), and ISED standard RSS-102, under given conditions (measured or rated RF output power, antenna gain, distance towards human body, multiple transmitter information as presented by the applicant). In addition, maximum antenna gain or minimum distance towards the human body is calculated, respectively, where relevant.

The device meets the limits as stipulated by the above given FCC/ISED rule parts based on available specifications.

Company Name	Product Description	Model #
u-blox AG	Cellular Module	SARA-R412M

Responsible for Testing Laboratory:

2019-1-24	Compliance	Cindy Li (Lab Manager EMC)	
Date	Section	Name	Signature

Responsible for the Report:

2019-1-24	Compliance	Kris Lazarov (EMC Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3.
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Contents

1. Assessment	2
2. Administrative Data	4
2.1. Identification of the Testing Laboratory Issuing the Test Report	4
2.2. Identification of the Client / Manufacturer	4
3. Equipment under Assessment	5
4. RF Exposure Limits	6
4.1. Power Density Limits acc. to FCC 1.1310(e).....	6
4.2. Routine Environmental Evaluation Categorical Exclusion Limits acc. to FCC 2.1091(c) ...	6
4.3. Exemption Limits for Routine Evaluation to RSS-102 2.5.2	6
4.4. Exposure Limits RSS-102 4	6
4.5. RF Exposure Estimation (MPE Estimation).....	6
5. Evaluations	7
5.1. Routine Environmental Evaluation Applicability Stand Alone transmission	7
6. Routine Environmental Evaluation Applicability Simultaneous Transmission.....	7
7. Revision History.....	8

2. Administrative Data

2.1. Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
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Lab Manager EMC:	Cindy Li
Responsible Project Leader:	Kris Lazarov

2.2. Identification of the Client / Manufacturer

Applicant's Name:	u-blox AG
Street Address:	Zuercherstrasse 68
City/Zip Code	Thalwil, CH-8800
Country	Switzerland

3. Equipment under Assessment

Model No	SARA-R412M
HW Version	324A01
SW Version	M0.07.00
FCC-ID	XPYUBX18ZO01
IC-ID	8595A-UBX18ZO01
HVIN:	SARA-R412M
PMN:	SARA-R412M
Product Description	Cellular Module
Transceiver Technology / Type(s) of Modulation	GSM 850 / 1900 / GMSK / 8PSK LTE Bands 2; 4; 5; 12; 13 / QPSK / 64-QAM
Frequency Range	GSM 850: Uplink: 824 – 850 MHz / Downlink: 869 – 894 MHz GSM 1900: Uplink: 1850 – 1910 MHz / Downlink: 1930 – 1990 MHz LTE Band 2: Uplink: 1850 – 1910 MHz / Downlink: 1930 – 1990 MHz LTE Band 4: Uplink: 1710 – 1755 MHz / Downlink: 2110 – 2155 MHz LTE Band 5: Uplink: 824 – 849 MHz / Downlink: 869 – 894 MHz LTE Band 12: Uplink: 699 – 716 MHz / Downlink: 729 – 746 MHz LTE Band 13: Uplink: 777 – 787 MHz / Downlink: 746 – 756 MHz
Co-located Transmitters/ Antennas	N/A
Max. declared antenna gain	GSM 850 = 1.71 dBi GSM 1900 = 2.32 dBi LTE Band 2 = 2.32 dBi LTE Band 4 = 1.57 dBi LTE Band 5 = 1.71 dBi LTE Band 12 = 2.83 dBi LTE Band 13 = 2.83 dBi See Note 1
Power Supply/ Rated Operating Voltage Range	3.2 VDC (Low) / 3.8 VDC (Nominal) / 4.5 VDC (Max)
Operating Temperature Range	–40°C ~ +85°C
Sample Revision	<input type="checkbox"/> Prototype <input checked="" type="checkbox"/> Production <input type="checkbox"/> Pre-Production
Device Category	<input type="checkbox"/> Fixed Installation <input checked="" type="checkbox"/> Mobile <input type="checkbox"/> Portable
Exposure Category	<input type="checkbox"/> Occupational/ Controlled <input checked="" type="checkbox"/> General Population/ Uncontrolled

Note: 1 The antenna information is for the external antenna provided with the u-blox EVK-R4 series evaluation kit.

4. RF Exposure Limits

The following basic limits and rules apply for the device described in Section 3 of this report.

4.1. Power Density Limits acc. to FCC 1.1310(e)

Frequency Range (MHz)	Power density (mW/cm ²)	Averaging time (minutes)
300-1500	$f/1500$	30
1500 – 100.000	1.0	30

4.2. Routine Environmental Evaluation Categorical Exclusion Limits acc. to FCC 2.1091(c)

- Operating frequency < 1.5GHz: excluded if ERP < 1.5W / 31.8dBm
- Operating frequency > 1.5GHz: excluded if ERP < 3.0W / 34.8dBm

Per KDB 447498 D01 FCC allows calculative estimation of RF exposure for mobile applications when routine environmental evaluation categorical exclusion applies and also for fixed applications.

4.3. Exemption Limits for Routine Evaluation to RSS-102 2.5.2

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- Operating frequency > 300MHz < 6GHz: and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

4.4. Exposure Limits RSS-102 4

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6

4.5. RF Exposure Estimation (MPE Estimation)

Having available the source based average output power and peak antenna gain or the ERP/EIRP of the specified device and for a known minimum distance of its radiating structures from the body of persons according to its use cases (at least 20cm) the power density at that distance can be estimated by the following formula for plane-wave equivalent conditions (far-field conditions), when ground reflection is neglected.

$$S = \frac{PG}{4\pi R^2}$$

Where: S = power density (mW/cm² or W/m²)
P = power input to the antenna (mW or W)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (cm or m)

5. Evaluations

5.1. Routine Environmental Evaluation Applicability Stand Alone transmission

Maximum antenna gain analysis for compliance with MPE limits

Band of Operation (MHz)	Maximum Conducted Output Power (dBm)	Duty Cycle (%)	Distance cm	Equivalent Conducted Output Power (Maximum Conducted Output Power x Duty Cycle) (mW)	Maximum antenna gain to comply with ISED Limit (dBi)	Maximum antenna gain to comply with FCC Limit (dBi)	Maximum antenna gain to comply with all limits (dBi)
GSM 850	33.25	12.5	20	264.19	6.90	10.19	6.90
GSM 1900	30.25	12.5	20	132.41	12.30	15.79	12.30
LTE B2	25	100	20	316.23	8.52	12.01	8.52
LTE B4	25	100	20	316.23	8.29	12.01	8.29
LTE B5	25	100	20	316.23	6.12	9.41	6.12
LTE B12	25	100	20	316.23	5.63	8.69	5.63
LTE B13	25	100	20	316.23	5.94	9.15	5.94

Power Density Calculation with the u-blox EVK-R4 series evaluation kit antenna

Band of Operation MHz	Antenna Gain dBi	EIRP dBm	Maximum Duty Cycle %	Distance cm	Power Density mW/cm ²
GSM 850	1.71	34.96	12.5	20	0.078
GSM 1900	2.32	32.57	12.5	20	0.045
LTE B2	2.32	27.32	100	20	0.107
LTE B4	1.57	26.57	100	20	0.090
LTE B5	1.71	26.71	100	20	0.093
LTE B12	2.83	27.83	100	20	0.120
LTE B13	2.83	27.83	100	20	0.120

6. Routine Environmental Evaluation Applicability Simultaneous Transmission

- No simultaneous transmissions are possible for this device.

7. Revision History

Date	Report Name	Changes to report	Prepared by
2018-11-26	EMC_CTSMC-003-18001_FCC_ISED_MPE	Initial Version	Kris Lazarov
2019-1-24	EMC_CTSMC-003-18001_FCC_ISED_MPE_Rev_1	Added the evaluation kit antenna information in section 3; Added the power density calculation in section 5	Kris Lazarov