InterLab®

RF Exposure and Maximum ERP/EIRP Assessment

For

EMMY-W165

FCC ID XPYEMMYW165

IC: 8595A-EMMYW165

Assessment Reference: MDE_UBLOX_1623_MPEa

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

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0 Summary

0.1 Technical Report Summary

Type of Report
RF Exposure and Maximum ERP/EIRP Assessment for a Host-based multiradio module with Wi-Fi, Bluetooth and NFC. Including RF Exposure for use with co-located radios on generic host device.

Applicable FCC Rules and ISED Canada Radio Standards Specification

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

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-12140-01-00
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Andreas Petz Dipl.-Ing. Marco Kullik
Report Template Version:	2016-05-15

1.2 Project Data

Responsible for assessment and report:	Mr. Imad Hjije
Date of Report:	2016-10-12

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

Kind of Device product description	WLAN 2.4 GHz, 5 GHz, BT, NFC, SRD (5.8 GHz) - Single Antenna
Product name	Host-based multiradio module with Wi-Fi, Bluetooth and NFC
Type	EMMY-W165
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	normal: 3.3 V DC low: 3.0 V DC high: 3.6 V DC
Modulation Type	Bluetooth LE: GFSK WLAN: DSSS, OFDM, HT20 MCS0 – MCS7, HT40 MCS0 –MCS7 please see each test protocol
General product description	EMMY-W165 is an ultra-compact multi-radio module providing Wi-Fi, Classic Bluetooth, Bluetooth low energy and NFC mode of operation. It is designed for both simultaneous and independent operations of: • Wi-Fi IEEE 802.11ac and a/b/g/n • Dual-mode Bluetooth 4.2 • NFC
Specific product description for the EUT	EMMY-W165: Shielded module, single antenna pin for WLAN 802.11 ac/a/b/g/n and Bluetooth communication
The EUT provides the following ports:	- DC power supply - antenna port - signal ports
Data rates	Bluetooth LE, GFSK: 1 Mbit/s WLAN b: please see chapter "WLAN Power Table" WLAN g: please see chapter "WLAN Power Table" WLAN n 20 MHz: please see chapter "WLAN Power Table" WLAN n 40 MHz: please see chapter "WLAN Power Table"
Power levels	Bluetooth LE: 5 dBm WLAN: please see chapter "WLAN Power Table"

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Sample Name	Sample Code	Description
DE1015031bb01	bb01	Conducted Sample "#2a"
Sample Parameter	**Value**	
Antenna	Antenna connector on evaluation board (target platform): The following antennas are designated for 2.4 and 5 GHz WLAN transmission on EMMY-W165, as well as Bluetooth on EMMY-W165. - Table 2 of Test Object Specification:	

				Peak gain [dBi]	
#	Manufacturer	Part number	Antenna type	2.4 GHz band	5 GHz band
W1	Antenova	A10194 [1]	SMD chip antenna 10x10x0.9 [mm]	1.8	4.1
W2	Linx	ANT-DB1-RAF-RPS [4]	Dual-band dipole antenna	2.5	**4.6**
W3	Taoglas	GW.40.2153	Dual-band dipole antenna	**3.74**	2.5
W4	Taoglas	GW.59.3153 [5]	Dual-band dipole antenna	2.37	2.93
W5	Walsin	RFDPA870900SBLB8G1	Dual-band dipole antenna	2	3
W6	Linx	ANT-2.4-CW-RCT-RP [3]	Single-band dipole antenna	2.2	N/A
W7	Delock	88395 [6]	Dual-band dipole antenna	1.5	2.1

Serial No.	-
HW Version	03
SW Version	N/A
Comment	-

Sample Name	Sample Code	Description
DE1015044aa01	aa01	Conducted Sample "#1"
Sample Parameter	**Value**	
Integral Antenna	Antenna on evaluation board (target platform): Antenova, Type A10194, SMD chip antenna, 1.8 dBi Peak gain in 2.4 GHz band, 4.1 dBi Peak gain in 5 GHz band	
Serial No.	-	
HW Version	03	
SW Version	N/A	
Comment	-	

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.

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
Evaluation board (target platform)	u-blox , 03, -, -	u-blox EVB-W16

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.

Device	**Details (Manufacturer, HW, SW, S/N)**	**Description**
AC/DC power supply (115 V 60 Hz)	PeakTech, -, -, 081062045	PeakTech 6005D

3 Evaluation Results

3.1 RF Exposure Evaluation

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

3.1.1 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/cm²)*
300 – 1,500	f/1500
1,500 – 100,000	1.0

Limits specified per RSS-102, Issue 5.

Frequency range (MHz)	*Power density (mW/cm²)*
300 – 6000	$0.002619\ f^{0.6834}$

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

3.1.2 Test Protocol

The below table is to determine the MPE values using the maximum gain values for this product.

Table for FCC Limits

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	FCC MPE Limit (mW/cm²)	MPE Value using Max gain (mW/cm²)	Separation distance (cm)	Verdict
WLAN b-Mode; 20 MHz	DSSS, 11 Mbps	100.0%	2462.0	23.6	229.09	1.0000	0.108	20	Pass
WLAN g-Mode; 20 MHz	OFDM, 36 Mbps	100.0%	2437.0	24.9	309.03	1.0000	0.146	20	Pass
WLAN n-Mode; 20 MHz	OFDM, MCS3	100.0%	2437.0	25.4	346.74	1.0000	0.163	20	Pass
WLAN n-Mode; 40 MHz	OFDM, MCS4	100.0%	2437.0	23.2	208.93	1.0000	0.098	20	Pass
Bluetooth	GFSK 1-DH1	30.88%	2402.0	10.3	3.31	1.0000	0.002	20	Pass
WLAN a-Mode; 20 MHz	6 Mbit/s	100.0%	5260.0	17	50.12	1.0000	0.029	20	Pass
WLAN n-Mode; 20 MHz	6,5 Mbit/s MCS0	100.0%	5260.0	16.8	47.86	1.0000	0.027	20	Pass
WLAN n-Mode; 40 MHz	13,5 Mbit/s MCS0	100.0%	5230.0	16.4	43.65	1.0000	0.025	20	Pass
WLAN ac-Mode	20 MHz; 6,5 Mbit/s MCS0	100.0%	5260.0	16.7	46.77	1.0000	0.027	20	Pass
WLAN ac-Mode	40 MHz; 13,5 Mbit/s MCS0	100.0%	5230.0	16.4	43.65	1.0000	0.025	20	Pass
WLAN ac-Mode	80 MHz; 433 Mbit/s MCS0	100.0%	5690.0	13.2	20.89	1.0000	0.012	20	Pass

Table for IC Limits

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Equivalent conducted output power (mW)	IC MPE Limit (mW/cm²)	MPE Value using Max gain (mW/cm²)	Separation distance (cm)	Verdict
WLAN b-Mode; 20 MHz	DSSS, 11 Mbps	100.0%	2462.0	23.6	229.09	0.5442	0.108	20	PASS
WLAN g-Mode; 20 MHz	OFDM, 36 Mbps	100.0%	2437.0	24.9	309.03	0.5404	0.146	20	PASS
WLAN n-Mode; 20 MHz	OFDM, MCS3	100.0%	2437.0	25.4	346.74	0.5404	0.163	20	PASS
WLAN n-Mode; 40 MHz	OFDM, MCS4	100.0%	2437.0	23.2	208.93	0.5404	0.098	20	PASS
Bluetooth	GFSK 1-DH1	30.88%	2402.0	10.3	3.31	0.5351	0.002	20	PASS
WLAN a-Mode; 20 MHz	6 Mbit/s	100.0%	5260.0	17	50.12	0.9142	0.029	20	PASS
WLAN n-Mode; 20 MHz	6,5 Mbit/s MCS0	100.0%	5260.0	16.8	47.86	0.9142	0.027	20	PASS
WLAN n-Mode; 40 MHz	13,5 Mbit/s MCS0	100.0%	5230.0	16.4	43.65	0.9107	0.025	20	PASS
WLAN ac-Mode	20 MHz; 6,5 Mbit/s MCS0	100.0%	5260.0	16.7	46.77	0.9142	0.027	20	PASS
WLAN ac-Mode	40 MHz; 13,5 Mbit/s MCS0	100.0%	5230.0	16.4	43.65	0.9107	0.025	20	PASS
WLAN ac-Mode	80 MHz; 433 Mbit/s MCS0	100.0%	5690.0	13.2	20.89	0.9647	0.012	20	PASS

3.2 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

3.2.1 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 per the following criteria.

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

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.

3.2.2 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 ≥ 20cm.
3. Separation distance between co-located transmitting antennas is 0cm.

3.2.3 Test Protocol

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 (mW)	Frequency (MHZ)	S_{eq} (mW/cm²)	S_{lin} (mW/cm²)	$\frac{S_{eq}}{S_{Lin}}$	Verdict
WLAN b-Mode; 20 MHz	DSSS, 11 Mbps	**229.0868**	2462.0	**0.1078**	1.0000	0.10782774	Pass
WLAN g-Mode; 20 MHz	OFDM, 36 Mbps	**309.0295**	2437.0	**0.1455**	1.0000	0.14545562	Pass
WLAN n-Mode; 20 MHz	OFDM, MCS3	**346.7369**	2437.0	**0.1632**	1.0000	0.16320389	Pass
WLAN n-Mode; 40 MHz	OFDM, MCS4	**208.9296**	2437.0	**0.0983**	1.0000	0.09834007	Pass
Bluetooth	GFSK 1-DH1	**3.3113**	2402.0	**0.0016**	1.0000	0.00155859	Pass
WLAN a-Mode; 20 MHz	6 Mbit/s	**50.1187**	5260.0	**0.0288**	1.0000	0.02875613	Pass
WLAN n-Mode; 20 MHz	6,5 Mbit/s MCS0	**47.8630**	5260.0	**0.0275**	1.0000	0.0274619	Pass
WLAN n-Mode; 40 MHz	13,5 Mbit/s MCS0	**43.6516**	5230.0	**0.0250**	1.0000	0.02504555	Pass
WLAN ac-Mode	20 MHz; 6,5 Mbit/s MCS0	**46.7735**	5260.0	**0.0268**	1.0000	0.02683679	Pass
WLAN ac-Mode	40 MHz; 13,5 Mbit/s MCS0	**43.6516**	5230.0	**0.0250**	1.0000	0.02504555	Pass
WLAN ac-Mode	80 MHz; 433 Mbit/s MCS0	**20.8930**	5690.0	**0.0120**	1.0000	0.01198755	Pass

Relative exposure for Primary Transmitter for Industry Canada							
OP-Mode	Mode	Output Power (mW)	Frequency (MHZ)	S_{eq} (mW/cm²)	S_{lin} (mW/cm²)	$\frac{S_{eq}}{S_{Lin}}$	Verdict
WLAN b-Mode; 20 MHz	DSSS, 11 Mbps	**229.0868**	2462.0	**0.1078**	0.5442	0.198147575	Pass
WLAN g-Mode; 20 MHz	OFDM, 36 Mbps	**309.0295**	2437.0	**0.1455**	0.5404	0.269164602	Pass
WLAN n-Mode; 20 MHz	OFDM, MCS3	**346.7369**	2437.0	**0.1632**	0.5404	0.30200765	Pass
WLAN n-Mode; 40 MHz	OFDM, MCS4	**208.9296**	2437.0	**0.0983**	0.5404	0.181977605	Pass
Bluetooth	GFSK 1-DH1	**3.3113**	2402.0	**0.0016**	0.5351	0.002912805	Pass
WLAN a-Mode; 20 MHz	6 Mbit/s	**50.1187**	5260.0	**0.0288**	0.9142	0.031453817	Pass
WLAN n-Mode; 20 MHz	6,5 Mbit/s MCS0	**47.8630**	5260.0	**0.0275**	0.9142	0.030038162	Pass
WLAN n-Mode; 40 MHz	13,5 Mbit/s MCS0	**43.6516**	5230.0	**0.0250**	0.9107	0.027502423	Pass
WLAN ac-Mode	20 MHz; 6,5 Mbit/s MCS0	**46.7735**	5260.0	**0.0268**	0.9142	0.02935441	Pass
WLAN ac-Mode	40 MHz; 13,5 Mbit/s MCS0	**43.6516**	5230.0	**0.0250**	0.9107	0.027502423	Pass
WLAN ac-Mode	80 MHz; 433 Mbit/s MCS0	**20.8930**	5690.0	**0.0120**	0.9647	0.012426571	Pass

Simultaneous exposure 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
Bluetooth	GFSK 1-DH1	2402	**0.0016**	0.1648	Compliant
WLAN n-Mode; 20 MHz	OFDM, MCS3	2437	**0.1632**		
Bluetooth	GFSK 1-DH1	2402	**0.0016**	0.0303	Compliant
WLAN a-Mode; 20 MHz	6 Mbit/s	5260	**0.0288**		

Simultaneous exposure 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
Bluetooth	GFSK 1-DH1	2402	**0.0029**	0.3049	Compliant
WLAN n-Mode; 20 MHz	OFDM, MCS3	2437	**0.3020**		
Bluetooth	GFSK 1-DH1	2402	**0.0029**	0.0344	Compliant
WLAN a-Mode; 20 MHz	6 Mbit/s	5260	**0.0315**		

Conclusion

The calculations above demonstrate that the highest calculated power density for the 2.4GHz Wi-Fi and 5 GHz Wi-Fi in combination with the highest calculated Bluetooth Power density are under the limits for General Population/Uncontrolled exposure. Thus, it can be concluded that all other modes, data rates and channel combinations supported by this device are also under these limits.