RF Exposure evaluation

Applicant Data:	u-blox AG Zürcher Strasse 68 8809 Thalwil Switzerland	
Product Data:	*description:*	Host-based automotive module with Wi-Fi and Bluetooth
	product:	JODY-W377-00A; JODY-W377-00B JODY-W374-00A; JODY-W374-00B
	trademark:	u-blox
	supported Technologies:	Bluetooth Classic, Bluetooth Low Energy, WLAN 2,4 GHz and WLAN 5 GHz
	device category:	mobile device
	environment:	General Population/Uncontrolled

FCC ID:	XPYJODYW377 XPYJODYW374
IC:	8595A-JODYW377 8595A-JODYW374

Standards
OET Bulletin 65 Edition 97-01 August 1997
RSS-102 Issue 5 – March 2015

FCC CFR 47, Part 2.1091: Radiofrequency radiation exposure evaluation: mobile devices.
FCC CFR 47, Part 2.1307: Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.
FCC CFR 47, Part 2.1310: Radiofrequency radiation exposure limits.

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Maximum Permissible Exposure

As specified in Chapter e(1) of 47 CFR Part 1.1310 – Limits for Maximum Permissible Exposure (MPE)

Table (ii) – Limits for General Population/ Uncontrolled Exposure

Frequency range (MHz)	Power density (mW/cm²)
300 – 1500	f/1500
1500 - 100000	1.0

As specified in Chapter 4 of RSS-102, Issue 5 – Exposure Limits

Table 4 - RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency range (MHz)	Power density (W/m²)	Power density (mW/cm²)
300-6000	$0.02619\ f^{0.6834}$	mW/cm²=W/m²*0.1
6000-150000	10	1.0

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Calculations

Equation OET bulletin 65, page 18, edition 97-01:

$S = P * G / (4 * \pi * R^2)$

$R = \sqrt{} (P * G / S_{lim} * 4 * \pi)$

$G = S_{lim} * 4 * \pi * R^2 / P$

Where:

S = power density (mW/cm²)
P = power input to the antenna (mW)
G = power gain of the antenna (mW)
R = distance to the centre of radiation of the antenna (cm)
S_{lim} = FCC / IC Limit (mW/cm²)

Simultaneous Transmission 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.

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

Where:

S_{eq} = S = power density (mW/cm²)
S_{lim} = FCC / IC Limit (mW/cm²)

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Assessment

With:

G = 2 dBi
R = 20 cm

		G			P		P*G	S	S_{lim}	S_{eq} / S_{lim}	
Operational Bands	Antenna Gain (dBi)	Antenna Gain -numeric- (mW)	Tune Up (dBm)	Output Power -conducted- (dBm)	Output Power -conducted- (mW)	Output power (EIRP) (dBm)	Output Power (EIRP) (mW)	Power Density value (mW/cm²)	FCC Limit (mW/cm²)	Relative Power Density value	Margin to FCC Limit (mW/cm²)
Bluetooth	2	1,5849	1,00	11,00	15,85	13,00	19,95	0,0050	1,0000	0,0050	0,9950
Bluetooth LE	2	1,5849	1,00	9,00	10,00	11,00	12,59	0,0032	1,0000	0,0032	0,9968
802.11b	2	1,5849	2,00	21,00	199,53	23,00	199,53	0,0629	1,0000	0,0629	0,9371
802.11g	2	1,5849	2,00	18,00	100,00	20,00	100,00	0,0315	1,0000	0,0315	0,9685
802.11n_HT 20	2	1,5849	2,00	17,00	79,43	19,00	79,43	0,0250	1,0000	0,0250	0,9750
802.11n_HT 40	2	1,5849	2,00	13,00	31,62	15,00	31,62	0,0100	1,0000	0,0100	0,9900
802.11ax_HT 20	2	1,5849	2,00	17,00	79,43	19,00	79,43	0,0250	1,0000	0,0250	0,9750
802.11ax_HT 40	2	1,5849	2,00	13,00	31,62	15,00	31,62	0,0100	1,0000	0,0100	0,9900
802.11a	2	1,5849	2,00	18,00	100,00	20,00	100,00	0,0315	1,0000	0,0315	0,9685
802.11n 20M	2	1,5849	2,00	17,00	79,43	19,00	79,43	0,0250	1,0000	0,0250	0,9750
802.11n 40M	2	1,5849	2,00	16,00	63,10	18,00	63,10	0,0199	1,0000	0,0199	0,9801
802.11ac 20M	2	1,5849	2,00	17,00	79,43	19,00	79,43	0,0250	1,0000	0,0250	0,9750
802.11ac 40M	2	1,5849	2,00	16,00	63,10	18,00	63,10	0,0199	1,0000	0,0199	0,9801
802.11ac 80M	2	1,5849	2,00	16,00	63,10	18,00	63,10	0,0199	1,0000	0,0199	0,9801
802.11ax 20M	2	1,5849	2,00	15,00	50,12	17,00	50,12	0,0158	1,0000	0,0158	0,9842
802.11ax 40M	2	1,5849	2,00	15,00	50,12	17,00	50,12	0,0158	1,0000	0,0158	0,9842
802.11ax 80M	2	1,5849	2,00	15,00	50,12	17,00	50,12	0,0158	1,0000	0,0158	0,9842

Simultaneous:

	1st Technology e.g. Bluetooth Classic (BT)	2nd Technology WLAN 2,4 GHz (WLAN24)	3rd Technology WLAN 5 GHz (WLAN5)
(S_{eq} / S_{lim})	0.0050	0.0629	0.0315
Sum of (S_{eq} / S_{lim}) BT+WLAN24+WLAN5	0.0994		
Limit	1.0000		
Conclusion	passed		

Note 1: only worst-case values are listed in the tables above
Note 2: the duty cycle correction factor is already included in the measurement values