

RF-EXPOSURE REPORT FCC 47 CFR Part 2.1091 Maximum permissible exposure	
Report Reference No	G0M-2302-1881-TFC091-W276-MP-V04
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	 A2LA Accredited Testing Laboratory, Certificate No.: 1983.01 FCC Test Firm Designation Number: DE0008 ISED Testing Laboratory site: 3470A
Applicant	u-blox AG
Address	Zürcherstrasse 68 8800 Thalwil Switzerland
Test Specification	According to FCC/ISED rules
Standard	FCC 47 CFR 2.1091
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	MAYA-W2 host-based multiradio modules
Model(s)	MAYA-W276-00B
Additional Model(s)	None
Brand Name(s)	u-blox
Hardware Version(s)	02, 03
Software Version(s)	1.0.0.39.1-18.80.1.p154.38
FCC ID	XPYMAYAW2B
Contains FCC ID	-
Test Result	PASSED

Possible test case verdicts:		
required by standard but not tested	N/T	
not required by standard	N/R	
test object does meet the requirement	P(PASS)	
test object does not meet the requirement	F(FAIL)	
Testing:		
Test Lab Temperature	20 °C - 30 °C	
Test Lab Humidity	25 % - 55 %	
Date of performance	2023-11-22	
Date of receipt of test item	2023-03-02	
Report:		
Compiled by	Burkhard Pudell	
Created by (+ signature) (Responsible)	Burkhard Pudell	
Approved by (+ signature) (Senior Expert Engineer)	Radwan Jaafar	
Date of Issue	2024-02-01	
Total number of pages	17	
General Remarks:		
The test results presented in this report relate only to the object tested. The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.		
Additional Comments:		
The data presented in the report was taken from measurements on Hardware version 02. Hardware version 03 was tested and found that the output power was not increased, so Hardware version 02 presents the worse-case of the variants.		

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2023-11-23	Initial Release	--
02	2023-11-30	Replaced document: G0M-2302-1881-TFC091-W276-MP-V01 Replaced by: G0M-2302-1881-TFC091-W276-MP-V02 Reason: Test reports USRC238221001 and USRC238221003 have been added to the reference documents.	R. Jaafar
03	2024-01-12	Replaced document: G0M-2302-1881-TFC091-W276-MP-V02 Replaced by: G0M-2302-1881-TFC091-W276-MP-V03 Reason: Change of Eurofins Product Service GmbH Test Reports as Reference Documents	R. Jaafar
04	2024-02-01	Replaced document: G0M-2302-1881-TFC091-W276-MP-V03 Replaced by: G0M-2302-1881-TFC091-W276-MP-V04 Reason: Add HW Version and new evaluation of results	St. Liebich

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EIRP	Equivalent Isotropic Radiated Power
EUT	Equipment Under Test
MPE	Maximum Permissible Exposure

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1 Equipment (Test Item) Under Test

Description	MAYA-W2 host-based multiradio modules
Model	MAYA-W276-00B
Additional Model(s)	None
Brand Name(s)	u-blox
Sample Identification	see Reference Documents
Hardware Version(s)	02, 03
Software Version(s)	1.0.0.39.1-18.80.1.p154.38
FCC ID	XPYMAYAW2B
Contains FCC ID	-
Equipment type	Radio Module
Environment	General public

1.1 Reference Documents

Document Type	Document No.	Issued by	Date
Test-Report	G0M-2302-1881-TFC407WF-W276-V03	Eurofins Product Service GmbH	2023-12-06
Test-Report	G0M-2302-1881-TFC247WF-W276-V03	Eurofins Product Service GmbH	2023-12-06
Test-Report	G0M-2302-1881-TFC247ZB-W276-V03	Eurofins Product Service GmbH	2023-12-06
Test-Report	G0M-2302-1881-TFC247BT-W276-V03	Eurofins Product Service GmbH	2023-12-05
Test-Report	G0M-2302-1881-TFC247BL-W276-V03	Eurofins Product Service GmbH	2023-12-05
Test-Report	USRC238221001	Eurofins E&E Wireless Taiwan Co., Ltd.	2023-11-24
Test-Report	USRC238221003	Eurofins E&E Wireless Taiwan Co., Ltd.	2023-11-24

1.2 Power density radiation sources

Mode	Operating Frequency [MHz]	Maximum conducted power [dBm]	Maximum radiated power [dBm EIRP]	Maximum duty cycle [%]	Maximum antenna gain [dBi]	Maximum antenna diameter [cm]
IEEE 802.11 (U-NII-1)	5240	19.5	24.6	100	5.1	N/A
IEEE 802.11 (2.4 GHz)	2422	18.6	22.7	100	4.1	N/A
IEEE 802.15.4 (2.4 GHz)	2440	19.42	23.52	26.5	4.1	N/A
Bluetooth	2402	15.75	19.85	77	4.1	N/A
Bluetooth LE	2402	18.08	22.18	87	4.1	N/A
Comment:						

1.3 Field strength radiation sources

None

1.4 Concurrent Sources

Concurrent operating conditions
IEEE 802.11 (U-NII-1) + IEEE 802.15.4 (2.4 GHz)
IEEE 802.11 (U-NII-1) + Bluetooth
IEEE 802.11 (U-NII-1) + Bluetooth LE
IEEE 802.11 (2.4 GHz) + IEEE 802.15.4 (2.4 GHz)
IEEE 802.11 (2.4 GHz) + Bluetooth
IEEE 802.11 (2.4 GHz) + Bluetooth LE
Comment:

2 Result Summary

FCC MPE Evaluation - Single radiation sources					
Product Standard Reference	Requirement	Reference Method	Mode	Distance [m]	Verdict
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (U-NII-1)	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (2.4 GHz)	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.15.4 (2.4 GHz)	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	Bluetooth	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	Bluetooth LE	0.20	PASS
Comment:					

FCC MPE Evaluation - Multi-transmitter sources					
Product Standard Reference	Requirement	Reference Method	Mode	Distance [m]	Verdict
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (U-NII-1) + IEEE 802.15.4 (2.4 GHz)	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (U-NII-1) + Bluetooth	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (U-NII-1) + Bluetooth LE	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (2.4 GHz) + IEEE 802.15.4 (2.4 GHz)	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (2.4 GHz) + Bluetooth	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (2.4 GHz)+ Bluetooth LE	0.20	PASS

3 RF-Exposure classification

RF-Exposure Categories	
Fixed	A fixed device is defined as a device physically secured at one fixed location and cannot be easily re-located.
Mobile	A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.
Portable	A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

RF-Exposure Categories	
Occupational / Controlled	Limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
General population / Uncontrolled	Exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

4 RF-Exposure limits

FCC Limits – General Population / Uncontrolled Exposure				
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [W/m ²]	Averaging time [min]
0.3 – 1.34	614	1.63	1000	30
1.34 – 30	824/f	2.19/f	1800/f ²	30
30 – 300	27.5	0.073	2	30
300 – 1500	-	-	f/150	30
1500 – 100000	-	-	10.0	30

FCC Limits – Occupational / Controlled Exposure				
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [W/m ²]	Averaging time [min]
0.3 – 3.0	614	1.63	1000	6
3.0 – 30	1842/f	4.89/f	9000/f ²	6
30 – 300	61.4	0.163	10.0	6
300 – 1500	-	-	f/30	6
1500 – 100000	-	-	50	6

5 RF-Exposure Evaluation

Evaluation Relations
$\lambda[m] = \frac{c \left[\frac{m}{s} \right]}{f[Hz]} ; R_{FF}[m] \geq \frac{2 \cdot D[m]^2}{\lambda[m]}$ $S[W/m^2] = \frac{P_{E.I.R.P.}[W]}{4\pi R[m]^2} ; R[m] = \sqrt{\frac{P_{E.I.R.P.}[W]}{4\pi S[W/m^2]}}$ $DCC [dB] = 10 \cdot \log_{10} \left(\frac{DC[\%]}{100} \right)$ $\sum_{i=1}^N \frac{S_i \left[\frac{W}{m^2} \right]}{S_{Li} \left[\frac{W}{m^2} \right]} + \sum_{j=1}^M \left(\frac{E_j \left[\frac{V}{m} \right]}{E_{Lj} \left[\frac{V}{m} \right]} \right)^2 + \sum_{k=1}^O \left(\frac{H_k \left[\frac{A}{m} \right]}{H_{Lk} \left[\frac{A}{m} \right]} \right)^2 < 1$

Evaluation Procedure
<u>Standalone operation evaluation:</u> For each radio and frequency band the worst case transmission mode with the highest peak conducted or radiated power is evaluated at the frequency that results in the most restrictive rf-exposure limit. From the peak power values, antenna gains and duty cycles taken from the reference documents, the source average radiated power values are calculated. From the average radiated power the power densities at antenna far-field distance is calculated. The distance from the radiation source for compliance power density is calculated. If the separation distance is lower than the far-field distance, the far-field distance is given as compliance separation distance because the plane wave power density assessment is only valid in the far-field of the radiation source. For radiation sources for which the average electric and magnetic fields are measured using field probes, the measured field strength values are compared to the reference limits. For those sources no calculations are performed. Compliance with the reference values is determined with the near field measurements. <u>Concurrent operation evaluation:</u> First the evaluation distance is set to an appropriate value. For all radiation sources for which power densities are calculated, the power densities at the evaluation distance are calculated and for all other sources the electric or magnetic field strengths are measured using field probes. Finally the ratios of the power densities and/or field strength values and the corresponding limits are calculated and summed and the sum is compared to the maximum of 1.

6 Single Source Evaluation Results - FCC

IEEE 802.11 (U-NII-1)	
Transmission Mode	
Transmission Frequency (f) [MHz]	5240
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	24.6
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	24.60
Power density	
Compliance power density limit [W/m ²]	10.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.574
Power density ratio @ 0.20 m	0.06
Distance for compliance power density (S=SL) [m]	0.048
Compliance	
Verdict	PASS
Comment:	

IEEE 802.11 (2.4 GHz)	
Transmission Mode	
Transmission Frequency (f) [MHz]	2422
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	22.7
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	22.70
Power density	
Compliance power density limit [W/m ²]	10.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.370
Power density ratio @ 0.20 m	0.04
Distance for compliance power density (S=SL) [m]	0.038
Compliance	
Verdict	PASS
Comment:	

IEEE 802.15.4 (2.4 GHz)	
Transmission Mode	
Transmission Frequency (f) [MHz]	2440
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	23.52
Maximum transmission duty cycle (DC)	0.26
Duty cycle correction (DCC) [dB]	-5.77
Average radiated power (PRAVG) [dBm EIRP]	17.75
Power density	
Compliance power density limit [W/m ²]	10.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.119
Power density ratio @ 0.20 m	0.01
Distance for compliance power density (S=SL) [m]	0.022
Compliance	
Verdict	PASS
Comment:	

Bluetooth	
Transmission Mode	
Transmission Frequency (f) [MHz]	2402
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	19.85
Maximum transmission duty cycle (DC)	0.77
Duty cycle correction (DCC) [dB]	-1.14
Average radiated power (PRAVG) [dBm EIRP]	18.71
Power density	
Compliance power density limit [W/m ²]	10.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.148
Power density ratio @ 0.20 m	0.01
Distance for compliance power density (S=SL) [m]	0.024
Compliance	
Verdict	PASS
Comment:	

Bluetooth LE	
Transmission Mode	
Transmission Frequency (f) [MHz]	2402
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	22.18
Maximum transmission duty cycle (DC)	0.87
Duty cycle correction (DCC) [dB]	-0.60
Average radiated power (PRAVG) [dBm EIRP]	21.58
Power density	
Compliance power density limit [W/m ²]	10.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.286
Power density ratio @ 0.20 m	0.03
Distance for compliance power density (S=SL) [m]	0.034
Compliance	
Verdict	PASS
Comment:	

7 Concurrent Evaluation Results - FCC

IEEE 802.11 (U-NII-1) + IEEE 802.15.4 (2.4 GHz)	
Information	
Number of concurrent modes	2
Evaluation distance [m]	0.20
Maximum MPE Ratios	
IEEE 802.11 (U-NII-1)	0.06
IEEE 802.15.4 (2.4 GHz)	0.01
Sum of MPE Ratios	
Sum	0.07
Compliance	
Verdict	PASS

IEEE 802.11 (U-NII-1) + Bluetooth	
Information	
Number of concurrent modes	2
Evaluation distance [m]	0.20
Maximum MPE Ratios	
IEEE 802.11 (U-NII-1)	0.06
Bluetooth	0.01
Sum of MPE Ratios	
Sum	0.07
Compliance	
Verdict	PASS

IEEE 802.11 (U-NII-1) + Bluetooth LE	
Information	
Number of concurrent modes	2
Evaluation distance [m]	0.20
Maximum MPE Ratios	
IEEE 802.11 (U-NII-1)	0.06
Bluetooth LE	0.03
Sum of MPE Ratios	
Sum	0.09
Compliance	
Verdict	PASS

IEEE 802.11 (2.4 GHz) + IEEE 802.15.4 (2.4 GHz)	
Information	
Number of concurrent modes	2
Evaluation distance [m]	0.20
Maximum MPE Ratios	
IEEE 802.11 (2.4 GHz)	0.04
IEEE 802.15.4 (2.4 GHz)	0.01
Sum of MPE Ratios	
Sum	0.05
Compliance	
Verdict	PASS

IEEE 802.11 (2.4 GHz) + Bluetooth	
Information	
Number of concurrent modes	2
Evaluation distance [m]	0.20
Maximum MPE Ratios	
IEEE 802.11 (2.4 GHz)	0.04
Bluetooth	0.01
Sum of MPE Ratios	
Sum	0.05
Compliance	
Verdict	PASS

IEEE 802.11 (2.4 GHz) + Bluetooth LE	
Information	
Number of concurrent modes	2
Evaluation distance [m]	0.20
Maximum MPE Ratios	
IEEE 802.11 (2.4 GHz)	0.04
Bluetooth LE	0.03
Sum of MPE Ratios	
Sum	0.07
Compliance	
Verdict	PASS

== = END OF TEST REPORT == =