

# FCC RF Exposure Evaluation

Report Number:

**F231636**

Equipment under Test (EUT):

**Dual band Wi-Fi 6 / Bluetooth 5.3 low energy module**

**IRIS-W1**

Applicant:

**u-blox AG**



Deutsche  
Akkreditierungsstelle  
D-PL-17186-01-00

## References

- [1] **CFR 47 Rule part 1** Practice and Procedure
- [2] **CFR 47 Rule part 2** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **KDB 447498 D04 Interim General RF Exposure Guidance v01**

Assessed and  
written by:

Signature

Reviewed and  
approved by:

Signature

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# 1 Identification

## 1.1 Applicant

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## 1.2 Manufacturer

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## 1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**  
**Königswinkel 10**  
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**Germany**

Accredited by *Deutsche Akkreditierungsstelle GmbH* in compliance with  
DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-06.

## 1.4 EUT (Equipment under Test)

EUT	
Test object: *	Dual band Wi-Fi 6 / Bluetooth 5.3 low energy module
Model name: *	IRIS-W1
Model number: *	IRIS-W101-00B IRIS-W106-00B
Order number: *	IRIS-W101-00B IRIS-W106-00B
FCC ID: *	XPYIRISW1
IC certification number: *	8595A-IRISW1
PMN: *	IRIS-W101-00B IRIS-W106-00B
HVIN: *	IRIS-W101-00B IRIS-W106-00B
FVIN: *	922600.0200.000 922700.0200.000
HMN: *	not applicable

\* Declared by the applicant

## 1.5 Technical Data of Equipment

General EUT data			
Power supply EUT / evaluation board: *	DC		
Supply voltage EUT: *	$U_{Nom} = 3.3 \text{ V}_{DC}$	$U_{Min} = 3.15 \text{ V}_{DC}$	$U_{Max} = 3.45 \text{ V}_{DC}$
Supply voltage Evaluation board: *	$U_{Nom} = 4.0 \text{ V}_{DC}$	$U_{Min} = 5.0 \text{ V}_{DC}$	$U_{Max} = 6.0 \text{ V}_{DC}$
Temperature range: *	-40°C to +85°C		
Lowest internal clock / radio radio frequency: *	40 MHz		
Highest internal clock / radio radio frequency:	5825 MHz		

IEEE 802.11 frequencies (2.4 GHz)	
20 MHz	
Channel 1	2412 MHz
Channel 2	2417 MHz
Channel 3	2422 MHz
Channel 4	2427 MHz
Channel 5	2432 MHz
Channel 6	2437 MHz
Channel 7	2442 MHz
Channel 8	2447 MHz
Channel 9	2452 MHz
Channel 10	2457 MHz
Channel 11	2462 MHz

Bluetooth® low energy frequencies			
Channel 00	2402 MHz	Channel 01	2404 MHz
Channel 02	2406 MHz	Channel 03	2408 MHz
...	...	...	...
Channel 18	2438 MHz	Channel 19	2440 MHz
...	...	...	...
Channel 36	2474 MHz	Channel 37	2476 MHz
Channel 38	2478 MHz	Channel 39	2480 MHz

802.15.4 frequencies			
Channel 11	2405 MHz	Channel 12	2410 MHz
...	...	...	...
Channel 18	2440 MHz	Channel 19	2445 MHz
Channel 25	2475 MHz	Channel 26	2480 MHz

IEEE 802.11 frequencies (5 GHz)	
20 MHz	
Channel 36	5180 MHz
Channel 40	5200 MHz
Channel 44	5220 MHz
Channel 48	5240 MHz
Channel 52	5260 MHz
Channel 48	5280 MHz
Channel 60	5300 MHz
Channel 64	5320 MHz
Channel 100	5500 MHz
Channel 104	5520 MHz
Channel 108	5540 MHz
Channel 112	5560 MHz
Channel 116	5580 MHz
Channel 120*	5600 MHz
Channel 124*	5620 MHz
Channel 128*	5640 MHz
Channel 132	5660 MHz
Channel 136	5680 MHz
Channel 140	5700 MHz
Channel 149	5745 MHz
Channel 153	5765 MHz
Channel 157	5785 MHz
Channel 161	5805 MHz
Channel 165	5825 MHz

IEEE 802.11 radio mode (2.4 + 5 GHz)	
Fulfils radio specification: *	IEEE 802.11 b IEEE 802.11 g IEEE 802.11 a IEEE 802.11 n (20 MHz) IEEE 802.11 ac (20 MHz) IEEE 802.11 ax20 (20 MHz)
Radio IC: *	NXP RW612ET / RW610 ET
Type of modulation: *	IEEE 802.11 a      BPSK, QPSK, 16-QAM, 64-QAM (6/9/12/18/24/36/48/54 Mbit/s)
	IEEE 802.11 n20      BPSK, QPSK, 16-QAM, 64-QAM (up to 72.2 Mbit/s 1 spatial stream) (up to 144.4 Mbit/s 2 spatial stream)
	IEEE 802.11 ac20      BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM (up to 86.65 Mbit/s 1 spatial stream) (up to 173.3 Mbit/s 2 spatial stream)
	IEEE 802.11 ax20      BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM (up to 143.4 Mbit/s 1 spatial stream) (up to 286.8 Mbit/s 2 spatial stream)
Operating frequency range: *	IEEE 802.11b      2412 – 2462 MHz
	IEEE 802.11g      2412 – 2462 MHz
	IEEE 802.11a      5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,
	IEEE 802.11n 20 MHz      2412 – 2462 MHz 5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,
	IEEE 802.11ac 20 MHz      2412 – 2462 MHz 5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,
	IEEE 802.11ax 20 MHz      2412 – 2462 MHz 5180 – 5240 MHz, 5260 – 5320 MHz 5500 – 5720 MHz, 5745 – 5825 MHz,

\* Declared by the applicant



Bluetooth® low energy radio mode	
Fulfils radio specification: *	Bluetooth® Low Energy (BLE) 5.3
Radio IC: *	NXP RW612ET / RW610 ET
Type of modulation: *	BLE (1 Mbps PHY)                      GFSK
	BLE (2 Mbps PHY)                      GFSK
	BLE (0.5 Mbps PHY)                    GFSK
	BLE (0.125 Mbps PHY)                GFSK
Operating frequency range: *	BLE (1 Mbps PHY)                      2402 – 2480 MHz
	BLE (2 Mbps PHY)                      2402 – 2480 MHz
	BLE (0.5 Mbps PHY)                    2402 – 2480 MHz
	BLE (0.125 Mbps PHY)                2402 – 2480 MHz
Number of channels: *	BLE (1 Mbps PHY)                      40 (2 MHz channel spacing)
	BLE (2 Mbps PHY)                      40 (2 MHz channel spacing)
	BLE (0.5 Mbps PHY)                    40 (2 MHz channel spacing)
	BLE (0.125 Mbps PHY)                40 (2 MHz channel spacing)

IEEE 802.15.4 radio mode	
Fulfils radio specification: *	IEEE 802.15.4
Radio IC: *	NXP RW612ET / RW610 ET
Type of modulation: *	O-QPSK                      250 kbps
Operating frequency range: *	2405 – 2480 MHz

\* Declared by the applicant

## 1.6 Additional Information

None

## 2 Evaluation Methods

### 2.1 RF exposure test exemptions for single sources

#### 2.1.1 General Exemption 1.1307(b)(3)(i)(A)

The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in [paragraph \(b\)\(3\)\(ii\)\(A\)](#) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

#### 2.1.2 SAR Based Exemption 1.1307(b)(3)(i)(B)

Determination of exemption

The available maximum time-averaged power of effective radiated power (ERP), whichever is greater, is less than or equal to the threshold  $P_{th}$  (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz inclusive.

For the following separation distances [d] and frequency ranges  $P_{th}$  is given by the following formulas

	0.5 cm $\leq$ d $\leq$ 20cm	20 cm < d $\leq$ 40 cm
0.2 GHz $\leq$ f < 1.5 GHz	$P_{th}(mW) = ERP_{20cm} \left( \frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 2040f$ $x = -\log_{10} \left( \frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 2040f$
1.5 GHz $\leq$ f $\leq$ 6 GHz	$P_{th}(mW) = ERP_{20cm} \left( \frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 3060$ $x = -\log_{10} \left( \frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 3060$

#### 2.1.3 MPE Based Exemption 1.1307(b)(3)(i)(C)

By using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least  $\lambda/2\pi$ , where  $\lambda$  is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of  $\lambda/4$  or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

RF Source frequency [MHz]	Threshold ERP [W]
0.3 -1.34	1920 R <sup>2</sup>
1.34 – 30	3450 R <sup>2</sup> /f <sup>2</sup>
30 – 300	3.83 R <sup>2</sup>
300 – 1500	0.0128 R <sup>2</sup> /f
1500 - 100000	19.2 R <sup>2</sup>

#### 2.1.4 Stand alone MPE evaluation limits

The human exposure to RF emissions from such devices could be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and / or power density. The limits for General Population / Uncontrolled Exposure are given in the following table from §1.1310(e)1:

Frequency Range [MHz]	Electric Field Strength (E) [V/m]	Magnetic Field Strength (H) [A/m]	Power Density (S) [mW/cm <sup>2</sup> ]	Averaging Time  E  <sup>2</sup> , H  <sup>2</sup> or S [min]
0.3 – 1.34	614	1.63	*(100)	< 30
1.34 – 30	824/f	2.19/f	*(180/f <sup>2</sup> )	< 30
30 – 300	27.5	0.073	0.2	< 30
300 – 1500			f/1500	< 30
1500 – 100,000			1.0	< 30

Limits for General Population / Uncontrolled Exposure.

Note: f = frequency in MHz; \* Plane – wave equivalent power density

d: minimum separation distance from antenna to the user

The power density is calculated as follows:

$$S = \frac{P \cdot G \cdot D}{4 \cdot \pi \cdot d^2}$$

Where:

P: conducted power

G: Antenna gain (linear)

D: Duty Cycle

## 2.2 RF exposure test exemptions for simultaneous transmission sources

### 2.2.1 1 mW Test Exemption for simultaneous transmission sources

As discussed in §1.1307(b)(3)(ii)(A) [1] the 1 mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

- a. When the maximum available power each individual transmitting antenna with the same time averaging period is  $\leq 1$  mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm
- b. When the aggregate maximum available power of all transmitting antennas is  $\leq 1$  mW in the same time-averaging period

This exemption may not be combined with any other exemption.

### 2.2.2 Simultaneous transmission SAR based and MPE based test exemptions

Although this is not a module integration in the sense of product approval, the procedure for simultaneous transmission specified in KDB 447498 D04 Interim General RF Exposure Guidance v01 in chapter 2.2 was taken into account:

According to the RF exposure KDB 447498 D04 General RF Exposure Guidance v01 in chapter 2.2.2:

This case is described in detail in § 1.1307(b)(3)(ii)(B) and covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of the following formular is satisfied.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

For these test exemptions to apply, the maximum output power, duty factor, and other applicable parameters used in the standalone ERP determination tests, must be the same, or corresponding to a more conservative choice, than those required for simultaneous transmission.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is  $\leq 1.0$ , according to calculated/estimated, numerically modelled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

### 2.2.3 Test exemption based on the SAR to Peak Location Separation Ratio

When the ERP-based condition in the previous section does not apply, a test exemption may be still applicable based on the SAR to peak location separation ratio (SPLSR) procedure.

In this case, the simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SPLSR that qualifies for the additional test exemption.

This ratio is defined as:

$$SPLSR = (SAR_1 + SAR_2)^{\frac{1.5}{R_i}}$$

Where:  $SAR_1$  and  $SAR_2$  = highest reported SAR or estimated SAR values for the two sources in the pair  $i$ , and  $R_i$  is their distance in mm.

When  $SPLSR \leq 0.0.4$  (rounded to two decimal digits), for all antenna pairs in the configuration, then the device qualifies for 1 g SAR test exemption.

When 10 g SAR applies (e.g. for extremities) the corresponding test exemption condition is  $SPLSR \leq 0.10$ .

If any antenna pair does not qualify for simultaneous transmission SAR test exemption, then the device must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Pub. 865664 D01.

### 3 Results of evaluation

#### 3.1 Used evaluation methods

RF Exposure test exemptions for single sources			
Used	Method	See sub-clause	Comment
<input type="checkbox"/>	General Exemption 1.1307(b)(3)(i)(A)	2.1.1	-
<input checked="" type="checkbox"/>	SAR Based Exemption 1.1307(b)(3)(i)(B)	2.1.2	-
<input type="checkbox"/>	MPE Based Exemption 1.1307(b)(3)(i)(C)	2.1.3	-
<input type="checkbox"/>	MPE Calculation	2.1.4	-

RF Exposure test exemptions for simultaneous transmission sources			
Used	Method	See sub-clause	Comment
<input checked="" type="checkbox"/>	Not applicable*	-	-
<input type="checkbox"/>	1 mW test Exemption acc. 2.2.1 [3]	2.2.1	
<input type="checkbox"/>	SAR and MPE Based Exemption acc. 2.2.2 [3]	2.2.2	
<input type="checkbox"/>	SAR to Peak location separation ratio acc. 2.2.3 [3]	-	

\*As declared no simultaneous transmission is possible

#### 3.2 Evaluation Distance

According to the CFR47 §2.1091 the device as declared by the applicant is a mobile device which is used at least with the following separation distances between the device and the users.

Antenna	Min separation distance as declared by the applicant
Antenna 1	4

### 3.3 WLAN 2.4 GHz Emissions

The following information are based on [1] Test-Report F231636E1 from Phoenix Testlab GmbH

#### Antenna 1 SAR Based Exemption 1.1307(b)(3)(i)(B)

P <sub>con</sub> [dBm] incl. Tuneup	P <sub>con</sub> [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Antenuation [dB]	P <sub>e.i.r.p</sub> [dBm]	P <sub>e.i.r.p</sub> [mW]	P <sub>e.r.p</sub> [dBm]	P <sub>e.r.p</sub> [mW]
19	79.43	2.37	0	21.37	137.09	19.22	83.59
Frequency [GHz]	d [cm]	ERP <sub>20cm</sub>	x	P <sub>th</sub> [mW]	P <sub>e.r.p.</sub> [mW]	Result	
2.437	3.1	3060	1.901	88.42	83.59	exempted	
for $0.5 \text{ cm} \leq D \leq 20 \text{ cm}$ and $1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$							

Due to the fact that for separation distances larger than D the value for P<sub>e.r.p</sub> is lower than P<sub>th</sub> this emission is exempted from SAR Evaluation

### 3.4 Bluetooth LE - 2.4 GHz Emissions

The following information are based on [1] Test-Report F231636E1 from Phoenix Testlab GmbH

#### Antenna 1 SAR Based Exemption 1.1307(b)(3)(i)(B)

P <sub>con</sub> [dBm] incl. Tuneup	P <sub>con</sub> [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Antenuation [dB]	P <sub>e.i.r.p</sub> [dBm]	P <sub>e.i.r.p</sub> [mW]	P <sub>e.r.p</sub> [dBm]	P <sub>e.r.p</sub> [mW]
17.3	53.70	2.37	0	19.67	92.68	17.52	56.51
Frequency [GHz]	d [cm]	ERP <sub>20cm</sub>	x	P <sub>th</sub> [mW]	P <sub>e.r.p.</sub> [mW]	Result	
2.44	2.5	3060	1.901	58.71	56.51	exempted	
for $0.5 \text{ cm} \leq D \leq 20 \text{ cm}$ and $1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$							

Due to the fact that for separation distances larger than D the value for P<sub>e.r.p</sub> is lower than P<sub>th</sub> this emission is exempted from SAR Evaluation

### 3.5 802.15.4 - 2.4 GHz Emissions

The following information are based on [1] Test-Report F231636E1 from Phoenix Testlab GmbH

#### Antenna 1 SAR Based Exemption 1.1307(b)(3)(i)(B)

P <sub>con</sub> [dBm] incl. Tuneup	P <sub>con</sub> [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Antenuation [dB]	P <sub>e.i.r.p</sub> [dBm]	P <sub>e.i.r.p</sub> [mW]	P <sub>e.r.p</sub> [dBm]	P <sub>e.r.p</sub> [mW]
13	19.95	2.37	0	15.37	34.43	13.22	21.00
Frequency [GHz]	d [cm]	ERP <sub>20cm</sub>	x	P <sub>th</sub> [mW]	P <sub>e.r.p</sub> [mW]	Result	
2.44	1.5	3060	1.901	22.23	21.00	exempted	
for $0.5 \text{ cm} \leq D \leq 20 \text{ cm}$ and $1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$							

Due to the fact that for separation distances larger than D the value for P<sub>e.r.p</sub> is lower than P<sub>th</sub> this emission is exempted from SAR Evaluation

### 3.6 WLAN 5 GHz Emissions

The following information are based on [1] Test-Report F231636E2 from Phoenix Testlab GmbH

#### Antenna 1 SAR Based Exemption 1.1307(b)(3)(i)(B)

P <sub>con</sub> [dBm] incl. Tuneup	P <sub>con</sub> [mW] incl. Tuneup	Ant. Gain [dBi]	P <sub>e.i.r.p</sub> [dBm]	P <sub>e.i.r.p</sub> [mW]	P <sub>e.r.p</sub> [dBm]	P <sub>e.r.p</sub> [mW]
18.6	72.44	3.4	22	158.49	19.85	96.64
Frequency [GHz]	d [cm]	ERP <sub>20cm</sub>	x	P <sub>th</sub> [mW]	P <sub>e.r.p</sub> [mW]	Result
5.6	4	3060	2.082	107.32	96.64	exempted
for $0.5 \text{ cm} \leq D \leq 20 \text{ cm}$ and $1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$						

Due to the fact that for separation distances larger than d the value for P<sub>e.r.p</sub> is lower than P<sub>th</sub> this emission is exempted from SAR Evaluation



## 4 Conclusion

The IRIS-W1 complies in all operational modes to the limits given in CFR 47 §1.1310(e)1 in a separation distance of 3.1 cm for antenna 1 for all technologies.

Technology	Min separation distance [cm]
WLAN 2.4 GHz	3.1
WLAN 5 GHz	4.0
Bluetooth LE	2.5
802.15.4	1.5
All technologies	4.0

## 5 Report History

Report Number	Date	Comment
F231636	10.07.2024	Initial Test Report
-	-	-
-	-	-