

FCC RF Exposure Evaluation

1. Product Information

FCC ID:	2AOVL-W97L-5DB
Product name	W97L
Model number	W97L-5DB
Power supply	DC 5V/100mA
Bluetooth	2402-2480MHz
Channel Number	79 channels for Bluetooth V4.1 (BT Classics) 40 channels for Bluetooth V4.1 (BT LE)
Channel Spacing	1MHz for Bluetooth V4.1 (BT Classics) 2MHz for Bluetooth V4.1 (BT LE)
Modulation Type	GFSK, $\pi/4$ -DQPSK, 8-DPSK for V4.1 (BT Classics) GFSK for Bluetooth V4.1 (BT LE)
WIFI(2.4G Band)	2412MHz-2462MHz
Channel Spacing	5MHz
Channel Number	11 channels for 20MHz bandwidth (2412~2462MHz) 7 channels for 40MHz bandwidth (2422~2452MHz)
Modulation Type	IEEE 802.11b: DSSS (CCK,DQPSK,DBPSK); IEEE 802.11g/n: OFDM (64QAM, 16QAM, QPSK, BPSK)
WIFI 5GWLAN (U-NI-1)	5180MHz-5240MHz
Channel Number	4 channels for 20MHz bandwidth (5180-5240MHz) 2 channels for 40MHz bandwidth (5190~5230MHz) 1 channels for 80MHz bandwidth (5210MHz)
Modulation Type	IEEE 802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
WIFI 5GWLAN (U-NI-3)	5745MHz-5825MHz
Channel Number	5 channels for 20MHz bandwidth (5745-5825MHz) 2 channels for 40MHz bandwidth (5755~5795MHz) 1 channels for 80MHz bandwidth (5775MHz)
Modulation Type	IEEE 802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
Antenna Type	ANT 0: Internal Antenna, used for Bluetooth TX/RX, ANT 1: External Antenna, used for WIFI TX/RX,
Antenna Gain	ANT 0: 2.0dBi(Max.) for Bluetooth ANT 1: 5.0dBi(Max.) for 2.4G and 5G Band
Hardware version	V2.0
Software version	V2.0
Bluetooth Operation frequency	2402MHz-2480MHz
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Portable

2. Evaluation Method

According to KDB447498 D01 General RF Exposure Guidance v06 Section 4.3.1 Standalone SAR test exclusion considerations: "Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure

conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition, listed below, is satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions.²² The minimum test separation distance is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander (see 5) of section 4.1). To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, typically in the SAR measurement or SAR analysis report, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for the SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops & tablets etc.”

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f} (\text{GHz})] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where:

- f (GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

When one of the following test exclusion conditions is satisfied for all combinations of simultaneous transmission configurations, further equipment approval is not required to incorporate transmitter modules in host devices that operate in the mixed mobile and portable host platform exposure conditions. The grantee is responsible for documenting this according to Class I permissive change requirements. Antennas that qualify for standalone SAR test exclusion must apply the estimated standalone SAR to determine simultaneous transmission test exclusion.

- a) The $[\sum$ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg] + $[\sum$ of MPE ratios] is ≤ 1.0 .
- b) The SAR to peak location separation ratios of all simultaneously transmitting antenna pairs operating in portable device exposure conditions are all ≤ 0.04 , and the $[\sum$ of MPE ratios] is ≤ 1.0 .

3. Refer Evaluation Method

[ANSI C95.1–1999](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[FCC KDB publication 447498 D01 General RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1093](#): Radiofrequency radiation exposure evaluation: portable devices

4. Conducted Power Results

4.1 Test Setup Block Diagram



4.2 Test Equipment

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Power Meter	R&S	NRVS	100444	2020-06-15
2	Power Sensor	R&S	NRV-Z32	10057	2020-06-15

Remark: all calibration period of equipment list is one year.

4.3 Test Procedure

The EUT was directly connected to the power meter and antenna output port as show in the block diagram Test Setup;

Setup EUT work at duty cycle more than 98%;

Read power sensor values in RMS detector;

BT

Mode	Channel	Frequency(MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	3.509
	39	2441	4.793
	78	2480	5.823
π/4DQPSK	0	2402	4.637
	39	2441	5.866
	78	2480	6.812
8DPSK	0	2402	4.863
	39	2441	6.048
	78	2480	6.900
LE GFSK	0	2402	2.839
	19	2440	4.230
	39	2480	5.369

WIFI(2.4G Band)

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
IEEE 802.11b	1	2412	8.278
	6	2437	8.374
	11	2462	8.596
IEEE 802.11g	1	2412	8.272
	6	2437	8.322
	11	2462	8.132
IEEE 802.11n HT20	1	2412	7.419
	6	2437	8.173
	11	2462	7.695
IEEE 802.11n HT40	3	2422	6.519
	6	2437	5.944
	9	2452	6.069

WIFI 5GWLAN (U-NI-1)

Mode	Channel	Frequency (MHz)	Maximum Average Conducted (dBm)
IEEE 802.11a	36	5180	5.87
	40	5200	5.44
	48	5240	6.54
IEEE 802.11n HT20	36	5180	4.65
	40	5200	5.06
	48	5240	5.61
IEEE 802.11n HT40	38	5190	5.57
	46	5230	5.84
IEEE 802.11ac HT20	36	5180	4.65
	40	5200	5.57
	48	5240	5.91
IEEE 802.11ac HT40	38	5190	5.38
	46	5230	6.22
IEEE 802.11ac HT80	42	5210	2.12

WIFI 5GWLAN (U-NI-3)

Mode	Channel	Frequency (MHz)	Maximum Average Conducted (dBm)
IEEE 802.11a	149	5745	5.653
	157	5785	6.261
	165	5825	6.579
IEEE 802.11n HT20	149	5745	4.461
	157	5785	5.447
	165	5825	5.716
IEEE 802.11n HT40	151	5755	2.800
	159	5795	3.609
IEEE 802.11ac HT20	149	5745	5.461
	157	5785	5.765
	165	5825	5.825
IEEE 802.11ac HT40	151	5755	3.771
	159	5795	3.568
IEEE 802.11ac HT80	155	5775	-0.052

5. Manufacturing Tolerance

BT

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	4.0	5.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0
π/4-DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	5.0	5.0	6.0
Tolerance ±(dB)	1.0	1.0	1.0
8DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	5.0	6.0	6.0
Tolerance ±(dB)	1.0	1.0	1.0
GFSK – BT LE(Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	3.0	4.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0

WIFI(2.4G Band)

IEEE 802.11b (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	8.0	8.0	8.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11g (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	8.0	8.0	8.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	8.0	8.0	8.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Peak)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	6.0	6.0	6.0
Tolerance \pm (dB)	1.0	1.0	1.0

WIFI 5GWLAN (U-NI-1)

IEEE 802.11a (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	6.0	6.0	6.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	5.0	5.0	5.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Channel	Channel 38	---	Channel 46
Target (dBm)	5.0	---	5.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac HT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	5.0	5.0	5.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11ac HT40 (Average)			
Channel	Channel 38	---	Channel 46
Target (dBm)	5.0	---	6.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac HT80 (Average)			
Channel	---	Channel 42	---
Target (dBm)	---	2.0	---
Tolerance \pm (dB)	---	1.0	---

WIFI 5GWLAN (U-NI-3)

IEEE 802.11a (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	6.0	6.0	6.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	5.0	5.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Channel	Channel 151	---	Channel 159
Target (dBm)	3.0	---	3.0
Tolerance ±(dB)	1.0	---	1.0
IEEE 802.11ac HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	5.0	5.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11ac HT40 (Average)			
Channel	Channel 151	---	Channel 159
Target (dBm)	3.0	---	3.0
Tolerance ±(dB)	1.0	---	1.0
IEEE 802.11ac HT80 (Average)			
Channel	---	Channel 155	---
Target (dBm)	---	0	---
Tolerance ±(dB)	---	1.0	---

6. Evaluation Results

6.1 Standalone Evaluation

Band/Mode	f (GHz)	Antenna Distance (mm)	RF output power		SAR Test Exclusion Threshold	SAR Test Exclusion
			dBm	mW		
IEEE 802.11a	5200	5	7.00	5.0119	2.29 < 3.0	Yes
	5800	5	7.00	5.0119	2.41 < 3.0	Yes
IEEE 802.11b	2450	5	9.00	7.9433	2.49 < 3.0	Yes
IEEE 802.11g	2450	5	9.00	7.9433	2.49 < 3.0	Yes
IEEE 802.11n HT20	2450	5	9.00	7.9433	2.49 < 3.0	Yes
	5200	5	6.00	3.9811	1.82 < 3.0	Yes
	5800	5	6.00	3.9811	1.92 < 3.0	Yes
IEEE 802.11n HT40	2450	5	7.00	5.0119	1.57 < 3.0	Yes
	5200	5	6.00	3.9811	1.82 < 3.0	Yes
	5800	5	4.00	2.5119	1.21 < 3.0	Yes
IEEE 802.11ac HT20	5200	5	6.00	3.9811	1.82 < 3.0	Yes
	5800	5	6.00	3.9811	1.92 < 3.0	Yes
IEEE 802.11ac HT40	5200	5	7.00	5.0119	2.29 < 3.0	Yes
	5800	5	4.00	2.5119	1.21 < 3.0	Yes
IEEE 802.11ac HT80	5200	5	3.00	1.9953	0.91 < 3.0	Yes
	5800	5	1.00	1.2589	0.61 < 3.0	Yes
GFSK	2450	5	6.00	3.9811	1.25 < 3.0	Yes
$\pi/4$ DQPSK	2450	5	7.00	5.0119	1.57 < 3.0	Yes
8DPSK	2450	5	7.00	5.0119	1.57 < 3.0	Yes
GFSK – BT LE	2450	5	6.00	3.9811	1.25 < 3.0	Yes

Remark:

(1). RF output power including tune up tolerance;

(2). When the minimum test separation distance is < 5 mm, a distance of 5 mm according to f) in section 4.1 of KDB 447498 is applied to determine SAR test exclusion.

6.2 Simultaneous Transmission for SAR Exclusion

The sample support BT modular and WLAN (WIFI(2.4G Band), WIFI 5GWLAN (U-NI-1), WIFI 5GWLAN (U-NI-3)) modular, BT and WLAN share difference antenna, need consider simultaneous transmission;

Mode	Evaluate Frequency (MHz)	Evaluate Antenna	Evaluate Distance (mm)	Maximum Conducted (or EIRP) (dBm)	SAR Estimated (W/kg)
IEEE 802.11a	5200	ANT 1	5	7.00	0.76
	5800	ANT 1	5	7.00	0.80
IEEE 802.11b	2450	ANT 1	5	9.00	0.83
IEEE 802.11g	2450	ANT 1	5	9.00	0.83
IEEE 802.11n HT20	2450	ANT 1	5	9.00	0.83
	5200	ANT 1	5	6.00	0.61
	5800	ANT 1	5	6.00	0.64
IEEE 802.11n HT40	2450	ANT 1	5	7.00	0.52
	5200	ANT 1	5	6.00	0.61
	5800	ANT 1	5	4.00	0.40
IEEE 802.11ac HT20	5200	ANT 1	5	6.00	0.61
	5800	ANT 1	5	6.00	0.64
IEEE 802.11ac HT40	5200	ANT 1	5	7.00	0.76
	5800	ANT 1	5	4.00	0.40
IEEE 802.11ac HT80	5200	ANT 1	5	3.00	0.30
	5800	ANT 1	5	1.00	0.20
GFSK	2450	ANT 0	5	6.00	0.42
$\pi/4$ DQPSK	2450	ANT 0	5	7.00	0.52
8DPSK	2450	ANT 0	5	7.00	0.52
GFSK – BT LE	2450	ANT 0	5	6.00	0.42

Maximum Simultaneous transmission SAR Ratio for BT and WLAN;

SAR Ratio _{BT}	SAR Ratio _{WLAN}	\sum SAR ratios	Limit	Results
< 0.52	< 0.83	< 0.84	1.0	PASS

7. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1093 for the uncontrolled RF Exposure and SAR Exclusion Threshold per KDB 447498 v06.

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