

RF Exposure evaluation

FCC ID: 2BAWK-SEC1004

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

1. Reference

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

KDB447498 D01: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

2. Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	6
3.0 – 30	1842/f	4.89/f	(900/f ²)*	6
30 – 300	61.4	0.163	1.0	6
300 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 30	824/f	2.19/f	(180/f ²)*	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	/	/	f/1500	30
1500 – 100,000	/	/	1.0	30

F=frequency in MHz

*=Plane-wave equivalent power density

3. MPE Calculation Method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG / 4\pi R^2$$

Where: S=power density

P=power input to antenna

G=power gain of the antenna in the direction of interest relative to an isotropic radiator

R=distance to the center of radiation of the antenna

4. Antenna Information

the can only use antennas certificated as follows provided by manufacturer;

List of WIFI/BT antenna

Type	Antenna type	Gain	Manufacturer
2JW1102 -C943B	External Dipole Antenna	2.4GHz:4.10dBi 5GHz: 3.90dBi	2J
YB0022AA	External Combo antenna	2.4GHz:2.60dBi 5GHz: 2.21dBi	QUECTEL
YEBT002W1AM	External Dipole Antenna	2.4GHz:2.90dBi 5GHz: 4.10dBi	QUECTEL

List of LTE antenna

Type	Antenna type	Gain	Manufacturer
2JW1102 -C943B	External Dipole Antenna	Band 2: 0.5dBi Band 4: 0.5dBi Band 5: -1.1dBi Band 12: -1.1dBi Band 13: -1.1dBi Band 25: 0.5dBi Band 26: -1.1dBi Band 66: 0.5dBi Band 41: 0.5dBi	2J
YB0022AA	External Combo antenna	Band 2: 1.27dBi Band 4: 1.27dBi Band 5: 0.56dBi Band 12: 1.90dBi Band 13: 1.90dBi Band 25: 1.27dBi Band 26: 0.56dBi Band 66: 1.27dBi Band 41: 2.30dBi	QUECTEL

YEBT002W1AM	External Dipole Antenna	Band 2: 4.60dBi Band 4: 1.27dBi Band 5: 1.90dBi Band 12: 1.40dBi Band 13: 1.40dBi Band 25: 2.23dBi Band 26: 1.90dBi Band 66: 1.27dBi Band 41: 3.60dBi	QUECTEL
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5. Manufacturing Tolerance

Band	Target Power	
	QPSK	16QAM
LTE BAND 2	23±2 dBm	22±2 dBm
LTE BAND 4	23±2 dBm	22±2 dBm
LTE BAND 5	23±2 dBm	22±2 dBm
LTE BAND 12	23±2 dBm	22±2 dBm
LTE BAND 13	23±2 dBm	22±2 dBm
LTE BAND 25	23±2 dBm	22±2 dBm
LTE BAND 26	23±2 dBm	22±2 dBm
LTE BAND 66	23±2 dBm	22±2 dBm
LTE BAND 41	23±2 dBm	22±2 dBm

Mode	Channel	Target Power PK (dBm)	Tolerance (dBm)
802.11b	1	14	±1
	6	12	±1
	11	11	±1
802.11g	1	18	±1
	6	17	±1
	11	16	±1
802.11n-HT20	1	18	±1
	6	16	±1
	11	19	±1
802.11n-HT40	3	16	±1
	6	16	±1
	9	19	±1

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Mode	Channel	Target Power AV (dBm)	Tolerance (dBm)
802.11a	36	11	± 1
	40	10	± 1
	48	9	± 1
802.11n(HT20)	36	9	± 1
	40	9	± 1
	48	9	± 1
802.11n(HT40)	38	8	± 1
	46	7	± 1
802.11ac(HT20)	36	9	± 1
	40	8	± 1
	48	8	± 1
802.11ac(HT40)	38	8	± 1
	46	7	± 1
802.11ac(HT80)	42	8	± 1

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Mode	Channel	Target Power AV (dBm)	Tolerance (dBm)
802.11a	149	10	± 1
	157	10	± 1
	165	9	± 1
802.11n(HT20)	149	9	± 1
	157	8	± 1
	165	8	± 1
802.11n(HT40)	151	8	± 1
	159	8	± 1
802.11ac(HT20)	149	8	± 1
	157	8	± 1
	165	7	± 1
802.11ac(HT40)	151	8	± 1
	159	8	± 1
802.11ac(HT80)	155	8	± 1

BT

Mode	Channel	Target Power
GFSK	0	-3 ± 1 dBm
	39	-3 ± 1 dBm
	78	-3 ± 1 dBm

$\pi/4$ DQPSK	0	-3 ± 1 dBm
	39	-3 ± 1 dBm
	78	-3 ± 1 dBm
8DPSK	0	-3 ± 1 dBm
	39	-3 ± 1 dBm
	78	-3 ± 1 dBm
BLE 1M	0	-3 ± 1 dBm
	19	-3 ± 1 dBm
	39	-3 ± 1 dBm

6. Standalone MPE Result

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r=20\text{cm}$, as well as the gain of the used antenna list in section 4, the RF power density can be obtained.

LTE

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE Radio
	dBm	mW					
LTE BAND 2	25.00	316.2278	4.60	2.8840	0.1814	1.0000	0.1814
LTE BAND 4	25.00	316.2278	1.27	1.3397	0.0843	1.0000	0.0843
LTE BAND 5	25.00	316.2278	1.90	1.5488	0.0974	0.5577	0.1746
LTE BAND 12	25.00	316.2278	1.90	1.5488	0.0974	0.4717	0.2065
LTE BAND 13	25.00	316.2278	1.90	1.5488	0.0974	0.5213	0.1868
LTE BAND 25	25.00	316.2278	4.60	2.8840	0.1814	1.0000	0.1814
LTE BAND 26	25.00	316.2278	1.90	1.5488	0.0974	0.5577	0.1746
LTE BAND 66	25.00	316.2278	1.27	1.3397	0.0843	1.0000	0.0843
LTE BAND 41	25.00	316.2278	3.60	2.2909	0.1441	1.0000	0.1441

2.4GHz WLAN

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE Radio
	dBm	mW					
IEEE 802.11b	15.00	31.6228	4.10	2.5704	0.0162	1.0000	0.0162
IEEE 802.11g	19.00	79.4328	4.10	2.5704	0.0406	1.0000	0.0406
IEEE 802.11n HT20	20.00	100.0000	4.10	2.5704	0.0511	1.0000	0.0511
IEEE 802.11n HT40	20.00	100.0000	4.10	2.5704	0.0511	1.0000	0.0511

5GHz WLAN Band 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE Radio
	dBm	mW					
IEEE 802.11a	12.00	15.8489	4.10	2.5704	0.0081	1.0000	0.0081
IEEE 802.11n HT20	10.00	10.0000	4.10	2.5704	0.0051	1.0000	0.0051
IEEE 802.11ac VHT20	10.00	10.0000	4.10	2.5704	0.0051	1.0000	0.0051
IEEE 802.11n HT40	9.00	7.9433	4.10	2.5704	0.0041	1.0000	0.0041
IEEE 802.11ac VHT40	9.00	7.9433	4.10	2.5704	0.0041	1.0000	0.0041
IEEE 802.11ac VHT80	9.00	7.9433	4.10	2.5704	0.0041	1.0000	0.0041

5GHz WLAN Band 3

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE Radio
	dBm	mW					
IEEE 802.11a	11.00	12.5893	4.10	2.5704	0.0064	1.0000	0.0064
IEEE 802.11n HT20	10.00	10.0000	4.10	2.5704	0.0051	1.0000	0.0051
IEEE 802.11ac VHT20	9.00	7.9433	4.10	2.5704	0.0041	1.0000	0.0041
IEEE 802.11n HT40	9.00	7.9433	4.10	2.5704	0.0041	1.0000	0.0041
IEEE 802.11ac VHT40	9.00	7.9433	4.10	2.5704	0.0041	1.0000	0.0041
IEEE 802.11ac VHT80	9.00	7.9433	4.10	2.5704	0.0041	1.0000	0.0041

BT

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE Radio
	dBm	mW					
BT	-2	0.6310	4.10	2.5704	0.0003	1.0000	0.0003

Remark:

1. Output power (Average) including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.

7. Summary simultaneous transmission information

The Device LTE and WIFI/BT can transmission simultaneously.

8. Summary simultaneous transmission results

Max. radio of LTE + Max. radio of WIFI/BT= $0.2065+0.0511=0.2576<1$

9. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

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