

RF Exposure evaluation

FCC ID: U7GBBGRM

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

$$S = \frac{PG}{4\pi R^2}$$

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

Blackbox-BBGR-M can only use antennas certificated as follows provided by manufacturer;

Antenna No.	Model No. of antenna:	Type of antenna:	Gain of the antenna (Max.)
Bluetooth	/	FPC Antenna	2.0dBi for 2400-2500MHz
2.4GWIFI	/	FPC Antenna	2.0dBi for 2400-2500MHz
GSM	/	External antenna	GSM850: 2.5 dbi, DCS1900: 2.50dbi
WCDMA	/	External antenna	FDD Band V:2.50dbi, FDD Band IV :2.50 dbi, FDD Band II:2.50dbi
LTE	/	External antenna	FDD Band 2: 2.50dBi, FDD Band 4: 2.50dBi, FDD Band 5: 2.50dBi, FDD Band 7: 2.50dBi, FDD Band 12: 2.50dBi, FDD Band 17: 2.50dBi, FDD Band 25: 2.50dBi, FDD Band 26: 2.50dBi,

5. Manufacturing Tolerance

<GSM>

Band	Mode	The Tune-up Maximum Power (Customer Declared)(dBm)
GSM 850	GPRS(GMSK, 1 Tx slot)	32.0±1.0
	GPRS(GMSK, 2 Tx slot)	30.0±1.0
	GPRS(GMSK, 3 Tx slot)	28.0±1.0
	GPRS(GMSK, 4 Tx slot)	27.0±1.0
	EDGE (8PSK, 1 Tx slot)	28.0±1.0
	EDGE (8PSK, 2 Tx slot)	26.0±1.0
	EDGE (8PSK, 3 Tx slot)	24.0±1.0
	EDGE (8PSK, 4 Tx slot)	23.0±1.0
GSM 1900	GPRS(GMSK, 1 Tx slot)	30.0±1.0
	GPRS(GMSK, 2 Tx slot)	27.0±1.0
	GPRS(GMSK, 3 Tx slot)	26.0±1.0
	GPRS(GMSK, 4 Tx slot)	26.0±1.0
	EDGE (8PSK, 1 Tx slot)	27.0±1.0
	EDGE (8PSK, 2 Tx slot)	25.0±1.0
	EDGE (8PSK, 3 Tx slot)	23.5±1.0
	EDGE (8PSK, 4 Tx slot)	23.0±1.0

<WCDMA>

Band	Mode	The Tune-up Maximum Power (Customer Declared)(dBm)
W-B2	RMC 12.2Kbps	21.5±2.0
	HSDPA Subtest-1	21.5±2.0
	HSDPA Subtest-2	21.5±2.0
	HSDPA Subtest-3	21.5±2.0
	HSDPA Subtest-4	21.5±2.0
	HSUPA Subtest-1	21.5±2.0
	HSUPA Subtest-2	21.5±2.0
	HSUPA Subtest-3	21.5±2.0
	HSUPA Subtest-4	21.5±2.0
	HSUPA Subtest-5	21.5±2.0
W-B4	RMC 12.2Kbps	21.5±2.0
	HSDPA Subtest-1	21.5±2.0
	HSDPA Subtest-2	21.5±2.0
	HSDPA Subtest-3	21.5±2.0
	HSDPA Subtest-4	21.5±2.0
	HSUPA Subtest-1	21.5±2.0
	HSUPA Subtest-2	21.5±2.0
	HSUPA Subtest-3	21.5±2.0
	HSUPA Subtest-4	21.5±2.0
	HSUPA Subtest-5	21.5±2.0
W-B5	RMC 12.2Kbps	21.5±2.0
	HSDPA Subtest-1	21.5±2.0
	HSDPA Subtest-2	21.5±2.0
	HSDPA Subtest-3	21.5±2.0
	HSDPA Subtest-4	21.5±2.0
	HSUPA Subtest-1	21.5±2.0
	HSUPA Subtest-2	21.5±2.0
	HSUPA Subtest-3	21.5±2.0
	HSUPA Subtest-4	21.5±2.0
	HSUPA Subtest-5	21.5±2.0

<LTE>

Mode	Target Power		
QPSK	1RB	50%RB	100%RB
LTE BAND 2	22.5 ± 1.5 dBm	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm
LTE BAND 4	22.5 ± 1.5 dBm	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm
LTE BAND 5	21.5 ± 2.0 dBm	21.5 ± 2.0 dBm	21.5 ± 2.0 dBm
LTE BAND 7	22.0 ± 1.5 dBm	22.0 ± 1.5 dBm	22.0 ± 1.5 dBm
LTE BAND 12	22.0 ± 1.5 dBm	22.0 ± 1.5 dBm	22.0 ± 1.5 dBm
LTE BAND 17	22.5 ± 1.5 dBm	22.5 ± 1.5 dBm	22.5 ± 1.5 dBm
LTE BAND 25	22.0 ± 1.5 dBm	22.0 ± 1.5 dBm	22.0 ± 1.5 dBm
LTE BAND 26(part 22)	22.5 ± 1.5 dBm	22.5 ± 1.5 dBm	22.5 ± 1.5 dBm
LTE BAND 26(part 90)	22.5 ± 1.5 dBm	22.5 ± 1.5 dBm	22.5 ± 1.5 dBm

Mode	Target Power		
16QAM	1RB	50%RB	100%RB
LTE BAND 2	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm
LTE BAND 4	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm
LTE BAND 5	20.5 ± 2.0 dBm	20.5 ± 2.0 dBm	20.5 ± 2.0 dBm
LTE BAND 7	21.0 ± 1.5 dBm	21.0 ± 1.5 dBm	21.0 ± 1.5 dBm
LTE BAND 12	21.0 ± 1.5 dBm	21.0 ± 1.5 dBm	21.0 ± 1.5 dBm
LTE BAND 17	21.0 ± 1.0 dBm	21.0 ± 1.0 dBm	21.0 ± 1.0 dBm
LTE BAND 25	20.5 ± 1.5 dBm	20.5 ± 1.5 dBm	20.5 ± 1.5 dBm
LTE BAND 26(part 22)	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm
LTE BAND 26(part 90)	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm	21.5 ± 1.5 dBm

<2.4GHz WLAN>

2G4WLAN			
IEEE 802.11b (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11g (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	14.0	14.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	12.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Peak)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	11.0	12.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

BT Classics			
GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	2.0	2.0	3.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
$\pi/4$ -DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	5.0	5.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
8-DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	5.0	5.0	6.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
BT LE			
GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	2.0	2.0	3.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

6. Standalone MPE Result

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 25 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r=25\text{cm}$, as well as the gain of WIFI/BT antenna is 2.0dBi, the gain of GSM/WCDMA/LTE antenna is 2.50dBi.the RF power density can be obtained.

<GSM&WCDMA<E>

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
GSM 850	33.0	1995.2623	2.50	1.7783	0.451997	0.5493
GSM 1900	31.0	1258.9254	2.50	1.7783	0.285191	1.0000
WCDMA B2	23.5	223.8721	2.50	1.7783	0.050715	1.0000
WCDMA B4	23.5	223.8721	2.50	1.7783	0.050715	1.0000
WCDMA B5	23.5	223.8721	2.50	1.7783	0.050715	0.5493
LTE B2	24.0	251.1886	2.50	1.7783	0.056903	1.0000
LTE B4	24.0	251.1886	2.50	1.7783	0.056903	1.0000
LTE B5	23.5	223.8721	2.50	1.7783	0.050715	0.5493
LTE B7	23.5	223.8721	2.50	1.7783	0.050715	1.0000
LTE B12	23.5	223.8721	2.50	1.7783	0.050715	0.4660
LTE B17	24.0	251.1886	2.50	1.7783	0.056903	1.0000
LTE B25	23.5	223.8721	2.50	1.7783	0.050715	1.0000
LTE B26 (part 22)	24.0	251.1886	2.50	1.7783	0.056903	0.5495
LTE B26 (part 90)	24.0	251.1886	2.50	1.7783	0.056903	0.5427

2.4GHz WLAN

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	14.0	25.1189	2.00	1.5849	0.005071	1.0000
IEEE 802.11g	15.0	31.6228	2.00	1.5849	0.006385	1.0000
IEEE 802.11n HT20	14.0	25.1189	2.00	1.5849	0.005071	1.0000
IEEE 802.11n HT40	13.0	19.9526	2.00	1.5849	0.004028	1.0000

BT

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
GFSK	4.0	2.5119	2.00	1.5849	0.000507	1.0000
$\pi/4$ DQPSK	6.0	3.9811	2.00	1.5849	0.000804	1.0000
8DPSK	7.0	5.0119	2.00	1.5849	0.001012	1.0000
BLE-GFSK	4.0	2.5119	2.00	1.5849	0.000507	1.0000

Remark:

1. Output power (Peak) 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 results

The sample supports 2 antennas for 2.4G WLAN& BT and GSM&WCDMA<E. The 2.4G WLAN& BT and GSM&WCDMA<E can transmit simultaneous.

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

Σ of MPE ratios ≤ 0.5493

Antenna 0 and Antenna 1 for 2.4GWLAN

Modulation Type	MPE _{GSM850} (mW/cm ²)	MPE _{WIFI} (mW/cm ²)	Σ MPE ratios	Limit	Results
Simultaneous	0.451997	0.006835	0.458832	0.5493	PASS

8. Conclusion

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

-----THE END OF REPORT-----