FCC RF Exposure

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

Refer Standard: KDB 447498 D01 General RF Exposure Guidance v06

FCC Part 2 §2.1091

1.   Evaluation method

Systems operating under the provisions of FCC 47 CFR 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.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible   Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0. 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 MPE limit, at the test frequency.   Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions.   The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

2.   Limits for General Population/Uncontrolled Exposure

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $|E|^2,|H|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

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

3.   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

From the EUT RF output power, the minimum mobile separation distance, d=0.6m, as well as the maximum gain of the used antenna as following table, the RF power density can be obtained.

Frequency Band	Mode	Internal Identification	Antenna type	Maximum Antenna Gain
2.4 GHz	Bluetooth*	Antenna 0	Ceramic Antenna	3.0dBi
	WLAN	Antenna 1	Ceramic Antenna	2.0dBi
450 MHz	PMR radio module	Antenna 2	External Antenna	5.0dBi
1.9 GHz	GSM/UMTS module	Antenna 3	Internal Antenna	2.0dBi
13.56 MHz	NFC module	Antenna 4	Loop Antenna	Only RX
1.5GHz	GPS Antenna	Antenna 5	Internal Antenna	Only RX

Bluetooth* - Bluetooth including Lower Energy Bluetooth and Classics Bluetooth

4.   Conducted Power Results

BT & WLAN			
Mode	**Channel**	**Frequency (MHz)**	**Conducted Peak Output Power (dBm,)**
IEEE 802.11 b	1	2412	15.36
	6	2437	15.58
	11	2462	15.45
IEEE 802.11 g	1	2412	20.65
	6	2437	20.87
	11	2462	20.45
IEEE 802.11 n HT20	1	2412	21.12
	6	2437	20.96
	11	2462	21.47
BT – LE (GFSK)	00	2402	0.32
	19	2440	0.35
	39	2480	0.25
BT – Classics (GFSK)	0	2402	3.84
	39	2441	3.52
	78	2480	2.89
BT – Classics (GFSK)	0	2402	2.08
	39	2441	1.94
	78	2480	1.80
BT – Classics (π /4 DQPSK)	0	2402	3.20
	39	2441	2.89
	78	2480	2.56
BT – Classics (8DPSK)	0	2402	3.54
	39	2441	2.78
	78	2480	2.52

450MHz PMR					
Modulation Type	Channel Separation	Operation Mode	Test Channel	Test Frequency (MHz)	Test Results (dBm)
Digital/GMSK	12.5KHz	High Rated Power	Ch1	460.125	34.72
			Ch2	465.125	34.74
			Ch3	469.125	34.78
		Low Rated Power	Ch1	460.125	30.37
			Ch2	465.125	30.39
			Ch3	469.125	30.43
Digital/GMSK	25KHz	High Rated Power	Ch4	460.125	34.74
			Ch5	465.125	34.73
			Ch6	469.125	34.72
		Low Rated Power	Ch4	460.125	30.34
			Ch5	465.125	30.33
			Ch6	469.125	30.10

GSM1900								
GSM 1900		Burst Conducted power (dBm)			/	Average power (dBm)		
		Channel/Frequency(MHz)				Channel/Frequency(MHz)		
		512/ 1850.2	661/ 1880	810/ 1909.8		512/ 1850.2	661/ 1880	810/ 1909.8
GPRS (GMSK)	1TX slot	29.85	29.65	29.15	-9.03dB	20.82	20.62	20.12
	2TX slot	27.56	27.12	27.21	-6.02dB	21.54	21.10	21.19
	3TX slot	**26.12**	**26.36**	**26.02**	**-4.26dB**	**21.86**	**22.10**	**21.76**
	4TX slot	24.26	24.48	24.15	-3.01dB	21.25	21.47	21.14
EGPRS (8PSK)	1TX slot	25.78	25.45	25.02	-9.03dB	16.75	16.42	15.99
	2TX slot	23.23	23.21	23.32	-6.02dB	17.21	17.19	17.30
	3TX slot	21.27	21.62	21.15	-4.26dB	17.01	17.36	16.89
	4TX slot	19.14	19.02	19.15	-3.01dB	16.13	16.01	16.14

Notes:

1. Division Factors

To average the power, the division factor is as follows:

1TX-slot = 1 transmit time slot out of 8 time slots=> conducted power divided by (8/1) => -9.00dB

2TX-slots = 2 transmit time slots out of 8 time slots=> conducted power divided by (8/2) => -6.00dB

3TX-slots = 3 transmit time slots out of 8 time slots=> conducted power divided by (8/3) => -4.26dB

4TX-slots = 4 transmit time slots out of 8 time slots=> conducted power divided by (8/4) => -3.00dB

2. According to the conducted power as above, the GPRS measurements are performed with 3Txslot GPRS1900.

UMTS Band II				
Item	**band**	**WCDMA Band II result (dBm)**		
		Channel/Frequency(MHz)		
	sub-test	9262/1852.4	9400/1880	9538/1907.6
RMC	12.2kbps RMC	23.27	23.43	**23.54**
	64kbps RMC	23.22	23.31	23.38
	144kbps RMC	23.14	23.20	23.29
	384kbps RMC	23.01	23.09	23.13
HSDPA	Sub - Test 1	22.54	22.59	22.19
	Sub - Test 2	22.37	22.01	21.51
	Sub - Test 3	22.63	22.25	21.21
	Sub - Test 4	22.56	22.09	20.78
HSUPA	Sub - Test 1	22.40	22.25	21.59
	Sub - Test 2	22.17	22.06	21.23
	Sub - Test 3	22.66	22.21	21.52
	Sub - Test 4	22.45	22.24	21.32
	Sub - Test 5	22.54	22.56	21.37

5.   Manufacturing tolerance

GSM 1900 GPRS (GMSK) (Burst Average Power)				
Channel		512	661	810
1 Txslot	Target (dBm)	29.0	29.0	29.0
	Tolerance ±(dB)	1.0	1.0	1.0
2 Txslot	Target (dBm)	27.0	27.0	27.0
	Tolerance ±(dB)	1.0	1.0	1.0
3 Txslot	Target (dBm)	26.0	26.0	26.0
	Tolerance ±(dB)	1.0	1.0	1.0
4 Txslot	Target (dBm)	24.0	24.0	24.0
	Tolerance ±(dB)	1.0	1.0	1.0
GSM 1900 EDGE (8PSK) (Burst Average Power)				
Channel		512	661	810
1 Txslot	Target (dBm)	25.0	25.0	25.0
	Tolerance ±(dB)	1.0	1.0	1.0
2 Txslot	Target (dBm)	23.0	23.0	23.0
	Tolerance ±(dB)	1.0	1.0	1.0
3 Txslot	Target (dBm)	21.0	21.0	21.0
	Tolerance ±(dB)	1.0	1.0	1.0
4 Txslot	Target (dBm)	19.0	19.0	19.0
	Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	23.0	23.0	23.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSDPA(sub-test 1)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSDPA(sub-test 2)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSDPA(sub-test 3)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSDPA(sub-test 4)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	21.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSUPA(sub-test 1)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSUPA(sub-test 2)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSUPA(sub-test 3)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSUPA(sub-test 4)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

UMTS Band II HSUPA(sub-test 5)		
Channel	Channel 9262	Channel 9400	Channel 9538
Target (dBm)	22.0	22.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0

WiFi 2.4G

IEEE 802.11b (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.0	15.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11g (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	20.0	20.0	20.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	21.0	21.0	21.0
Tolerance ±(dB)	1.0	1.0	1.0

Bluetooth

BLE-GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	0.0	0.0	0.0
Tolerance ±(dB)	1.0	1.0	1.0
GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	3.0	3.0	3.0
Tolerance ±(dB)	1.0	1.0	1.0
8DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	3.0	3.0	3.0
Tolerance ±(dB)	1.0	1.0	1.0
π/4DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	3.0	3.0	3.0
Tolerance ±(dB)	1.0	1.0	1.0

450MHz PMR

Digital/GMSK/12.5KHz/High Rated Power			
Channel	Channel 1	Channel 2	Channel 3
Target (dBm)	34.0	34.0	34.0
Tolerance ±(dB)	1.0	1.0	1.0
Digital/GMSK/12.5KHz/Low Rated Power			
Channel	Channel 1	Channel 2	Channel 3
Target (dBm)	30.0	30.0	30.0
Tolerance ±(dB)	1.0	1.0	1.0
Digital/GMSK/25KHz/High Rated Power			
Channel	Channel 4	Channel 5	Channel 6
Target (dBm)	34.0	34.0	34.0
Tolerance ±(dB)	1.0	1.0	1.0
Digital/GMSK/25KHz/Low Rated Power			
Channel	Channel 4	Channel 5	Channel 6
Target (dBm)	30.0	30.0	30.0
Tolerance ±(dB)	1.0	1.0	1.0

6.   Measurement Results

6.1   *Standalone MPE*

WLAN

Mode	Output power		Antenna Gain	Antenna Gain	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	(dBm)	(mW)	(dBi)	(linear)			
IEEE 802.11 b	16.00	39.8101	2.0	1.5849	100%	0.0014	1.000
IEEE 802.11 g	21.00	125.8925	2.0	1.5849	100%	0.0044	1.000
IEEE 802.11 n HT20	22.00	158.4893	2.0	1.5849	100%	0.0056	1.000

Bluetooth

Mode	Output power		Antenna Gain	Antenna Gain	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	(dBm)	(mW)	(dBi)	(linear)			
GFSK – LE	1.00	1.2589	3.0	1.9953	100%	0.0001	1.000
GFSK	4.00	2.5119	3.0	1.9953	100%	0.0001	1.000
π/4DQPSK	4.00	2.5119	3.0	1.9953	100%	0.0001	1.000
8DPSK	4.00	2.5119	3.0	1.9953	100%	0.0001	1.000

GSM1900 and UMTS Band II

Mode	Output power		Antenna Gain	Antenna Gain	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	(dBm)	(mW)	(dBi)	(linear)			
GSM 1900	27.00	501.1873	2.0	1.5849	37.5%	0.0066	1.000
UMTS Band II	24.00	251.1886	2.0	1.5849	100%	0.0088	1.000

450 MHz PMR

Mode	Output power		Antenna Gain	Antenna Gain	Duty Cycle	MPE (mW/cm²)	MPE Limits (mW/cm²)
	(dBm)	(mW)	(dBi)	(linear)			
Op 1	35.00	3162.2777	5.0	3.1623	100%	0.2212	0.3067
Op 2	31.00	1258.9254	5.0	3.1623	100%	0.0880	0.3067
Op 3	35.00	3162.2777	5.0	3.1623	100%	0.2212	0.3067
Op 4	31.00	1258.9254	5.0	3.1623	100%	0.0880	0.3067

Remark:

1. *Bluetooth*- Including Lower Energy Bluetoothand Classics Bluetooth*
2. *Maximum output power including tune-up tolerance;*
3. *The minimum use distance is 60cm from manufacturer declaration of user manual.*
4. *We use lowest frequency 460MHz to evlaute MPE limits.*
5. *Defination*

    Op 1 : Digital/GMSK/12.5KHz/High Rated Power

    Op 2 : Digital/GMSK/12.5KHz/Low Rated Power

    Op 3 : Digital/GMSK/25KHz/High Rated Power

    Op 4 : Digital/GMSK/25KHz/Low Rated Power

6.2 *Simultaneous transmission MPE*

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

∑ of MPE ratios ≤ 1.0

The sample share 6 difference antennas, Bluetooth, WLAN, PMR and GSM/UMTS share difference transmit antenna, NFC and GPS share difference receiver antenna, we only need consider Bluetooth, WLAN, PMR and GSM/UMTS simultaneous transmission MPE;

We evaluate all conditions simultaneous transmission and record worst case at Bluetooth, WLAN, PMR and GSM/UMTS simultaneous transmission.

Maximum MPE ratio 2.4GWLAN	Maximum MPE ratio 2.4GBluetooth*	Maximum MPE ratio GSM/UMTS	Maximum MPE ratio 450MHzPMR	∑MPE ratios	Limit	Results
0.0056	0.0001	0.0088	0.7212	0.8	1.0	PASS

Remark:

1. *Bluetooth*- Including Lower Energy Bluetoothand Classics Bluetooth*
2. *Maximum output power including tune-up tolerance;*
3. *The minimum use distance is 60cm from manufacturer declaration of user manual.*
4. *We use lowest frequency 450MHz to evlaute MPE limits.*

7.   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---------------