RF Exposure Evaluation

FCC ID: XN3-QTS-25

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

Refer Standard:

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 1 RF Exposure Guidance v05r01: 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 2.1091: Radiofrequency radiation exposure evaluation: mobile devices.

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 modelled 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. 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. Estimation Result

4.1 Conducted Power Results

For Single Antenna

ANTENNA 1			
TX Channel Bandwidth	**Frequency (MHz)**	**Burst Average Power [dBm]**	
		QPSK	**16QAM**
7 MHz	2503.500	16.31	15.83
	2595.000	16.79	16.29
	2686.500	15.16	16.04
8.75MHz	2504.375	16.37	15.86
	2595.000	16.67	15.90
	2685.625	15.34	15.37
10 MHz	2505.000	15.77	15.50
	2595.000	16.06	15.88
	2685.000	15.34	15.12

ANTENNA 2			
TX Channel Bandwidth	**Frequency (MHz)**	**Burst Average Power [dBm]**	
		QPSK	**16QAM**
7 MHz	2503.500	16.74	15.50
	2595.000	16.68	16.13
	2686.500	16.89	16.43
8.75MHz	2504.375	16.54	16.23
	2595.000	16.46	16.21
	2685.625	16.75	16.39
10 MHz	2505.000	16.97	16.24
	2595.000	16.03	15.59
	2685.000	16.77	16.01

For MIMO

TX Channel Bandwidth	**Frequency (MHz)**	**Burst Average Power [dBm]**					
		QPSK			**16QAM**		
		Antenna 1	**Antenna 2**	**Sum**	**Antenna 1**	**Antenna 2**	**Sum**
7 MHz	2503.500	16.31	16.74	19.54	15.83	15.50	18.68
	2595.000	16.79	16.68	19.75	16.29	16.13	19.22
	2686.500	16.16	16.89	19.12	16.04	16.43	19.25
8.75MHz	2504.375	16.37	16.54	19.47	15.86	16.23	19.06
	2595.000	16.67	16.46	19.58	15.90	16.21	19.07
	2685.625	16.34	16.75	19.11	15.37	16.39	18.92
10 MHz	2505.000	16.77	16.97	19.42	15.50	16.24	18.90
	2595.000	16.06	16.03	19.06	15.88	15.59	18.75
	2685.000	16.34	16.77	19.12	15.12	16.01	18.60

4.2 Manufacturing tolerance

For Single Antenna

Antenna 1 (Burst Average Power) _ Channel Bandwidth 7 MHz						
Channel (MHz)	2503.500		2595.000		2686.500	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	16.0	15.0	16.0	16.0	16.0	16.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Antenna 1 (Burst Average Power) _ Channel Bandwidth 8.75 MHz						
Channel (MHz)	2504.375		2595.000		2685.625	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	16.0	15.0	16.0	15.0	16.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Antenna 1 (Burst Average Power) _ Channel Bandwidth 10 MHz						
Channel (MHz)	2505.000		2595.000		2685.000	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	16.0	15.0	16.0	15.0	16.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

Antenna 2 (Burst Average Power) _ Channel Bandwidth 7 MHz						
Channel (MHz)	2503.500		2595.000		2686.500	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Antenna 1 (Burst Average Power) _ Channel Bandwidth 8.75 MHz						
Channel (MHz)	2504.375		2595.000		2685.625	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Antenna 1 (Burst Average Power) _ Channel Bandwidth 10 MHz						
Channel (MHz)	2505.000		2595.000		2685.000	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

For MIMO

MIMO (Burst Average Power) _ Channel Bandwidth 7 MHz						
Channel (MHz)	2503.500		2595.000		2686.500	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	19.0	18.0	19.0	19.0	19.0	19.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
MIMO (Burst Average Power) _ Channel Bandwidth 8.75 MHz						
Channel (MHz)	2504.375		2595.000		2685.625	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	19.0	19.0	19.0	19.0	19.0	19.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
MIMO (Burst Average Power) _ Channel Bandwidth 10 MHz						
Channel (MHz)	2505.000		2595.000		2685.000	
	QPSK	16QAM	QPSK	16QAM	QPSK	16QAM
Target (dBm)	19.0	18.0	19.0	18.0	19.0	18.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

4.3 Measurement Results

4.3.1 Standalone MPE

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 =20cm, as well as the gain of the used antenna is 12dBi, the RF power density can be obtained.

For Antenna 1

Modulation Type	Max. Output Power (dBm)	Max. Output Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Minimum Evaluation Distance (cm)	Max. Power Density At 30 cm (mW/cm^2)	Power Density Limit FCC (mW/cm^2)	Test Results
QPSK	17.00	50.1187	12.00	15.8489	30.00	0.1581	1.0000	Pass
16QAM	17.00	50.1187	12.00	15.8489	30.00	0.1581	1.0000	Pass

For Antenna 2

Modulation Type	Max. Output Power (dBm)	Max. Output Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Minimum Evaluation Distance (cm)	Max. Power Density At 20 cm (mW/cm^2)	Power Density Limit FCC (mW/cm^2)	Test Results
QPSK	17.00	50.1187	12.00	15.8489	30.00	0.1581	1.0000	Pass
16QAM	17.00	50.1187	12.00	15.8489	30.00	0.1581	1.0000	Pass

Note:

1. *Maximum output power including Turn-up tolerance.*
2. *The estimation distance is 20cm*

4.3.2 Simultaneous Transmission

The sample support 2*2 MIMO technologies, the 2 antennas can transmit simultaneous.
According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
∑ of MPE ratios ≤ 1.0

Simultaneous transmission MPE

Maximum MPE Ratios at Antenna 1	Maximum MPE Ratios at Antenna 1	Max.sum of the MPE ratios	Limit	Test Results
0.1581	0.1581	0.3	1.0	Pass

5. Conclusion

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