Maximum Permissible Exposure Report

1. Product Information

FCC ID:	2AYOW-IOT-1110
Product name	IOT Gateway
Test Model	IOT-1110
Additional Models No.	IOT-1111, SC20-NA-WE0-00
Models Declaration	PCB board, structure and internal of these model(s) are the same, So no additional models were tested
Modulation Type	802.11b: DSSS; 802.11g/n: OFDM, QPSK for LTE
Antenna Gain	Internal Antenna, 0dBi (Max.) For 2.4G WIFI External Antenna; 0dBi (max.) For E-UTRA Band 2 0dBi (max.) For E-UTRA Band 4 0dBi (max.) For E-UTRA Band 5
Hardware version	V1.0
Software version	1.0
UMTS Operation Frequency Band	Not Supported
LTE Operation Frequency Band	LTE FDD band 2, 4, 5
GSM/EDGE/GPRS	Not Supported
WCDMA Release Version	R8
HSDPA Release Version	Release 8
HSUPA Release Version	Release 6
DC-HSUPA Release Version	Not Supported
LTE Release Version	R10
LTE/UMTS Power Class	Class 3
WLAN FCC Modulation Type	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g/n: OFDM(64QAM, 16QAM, QPSK, BPSK)
WLAN FCC Operation frequency	IEEE 802.11b:2412-2462MHz IEEE 802.11g/n20:2412-2462MHz IEEE 802.11n40:2422-2452MHz
Antenna Type	External Antenna
Extreme temp. Tolerance	-20°C to +70°C
GPS function	Not Supported
FM function	Not Supported
NFC Function	Not Supported
Extreme vol. Limits	4.25VDC to 5.75VDC (nominal: 5VDC)
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

2. 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.

3. Limit

3. 1 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 1 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 2.1091: Radiofrequency radiation exposure evaluation: mobile devices

3. 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

4. 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

5. Antenna Information

Cellular Wi-Fi Router can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Notes
Internal Antenna	2400 MHz – 2500 MHz	0 dBi	WLAN ANT
External Antenna	600 MHz – 3000 MHz	0 dBi	LTE Main ANT

6. Conducted Power

[2.4GWLAN Max Peak Conducted Power]

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
IEEE 802.11b	1	2412	15.91
	6	2437	15.69
	11	2462	15.48
IEEE 802.11g	1	2412	14.27
	6	2437	14.19
	11	2462	14.22
IEEE 802.11n HT20	1	2412	13.04
	6	2437	13.02
	11	2462	12.96
IEEE 802.11n HT40	3	2422	13.04
	6	2437	12.28
	9	2452	12.22

[LTE Max Average Power]

Test Mode		Channel	Max Average Power (dBm)
LTE	Band 2	LCH	23.48
		MCH	24.23
		HCH	23.47
	Band 4	LCH	23.77
		MCH	23.58
		HCH	23.59
	Band 5	LCH	24.72
		MCH	24.63
		HCH	24.61

7. Manufacturing Tolerance

[2.4GWLAN Max Conducted Power]

Test Mode	Channel	Max Conducted Power (dBm)	ANT Max. Tune Up Power (dBm)
IEEE 802.11b	LCH	15.91	16.0±1.0
	MCH	15.69	16.0±1.0
	HCH	15.48	16.0±1.0
IEEE 802.11g	LCH	14.27	14.0±1.0
	MCH	14.19	14.0±1.0
	HCH	14.22	14.0±1.0
IEEE 802.11n HT20	LCH	13.04	13.0±1.0
	MCH	13.02	13.0±1.0
	HCH	12.96	13.0±1.0
IEEE 802.11n HT40	LCH	13.04	13.0±1.0
	MCH	12.28	13.0±1.0
	HCH	12.22	13.0±1.0

<LTE Max Average Power>

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 2	LCH	23.48	24.0±1.0
		MCH	24.23	24.0±1.0
		HCH	23.47	24.0±1.0
	Band 4	LCH	23.77	24.0±1.0
		MCH	23.58	24.0±1.0
		HCH	23.59	24.0±1.0
	Band 5	LCH	24.72	24.0±1.0
		MCH	24.63	24.0±1.0
		HCH	24.61	24.0±1.0

8. Measurement Results

8.1 Standalone MPE Evaluation

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 refer to antenna information, the RF power density can be obtained.

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11b	17.0	50.1187	0	1.0000	0.0100	1.0
IEEE 802.11g	15.0	31.6228	0	1.0000	0.0063	1.0
IEEE 802.11n HT20	14.0	25.1189	0	1.0000	0.0050	1.0
IEEE 802.11n HT40	14.0	25.1189	0	1.0000	0.0050	1.0

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
LTE Band 2	25.0	316.2278	0	1.0000	0.0629	1.0
LTE Band 4	25.0	316.2278	0	1.0000	0.0629	1.0
LTE Band 5	25.0	316.2278	0	1.0000	0.0629	0.55

Remark:
1. Output power including turn-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer;
3. We choose the lowest frequency operate to calculate MPE limit as higher frequency will have higher MPE limits;
4. MPE values = $PG/4\pi R^2$.

8.2 Simultaneous Transmission MPE

The sample support one 2.4GWLAN and another one LTE transmit antenna, so need consider simultaneous transmission;
Simultaneous transmission MPE
According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
$\sum$ of MPE ratios ≤ 1.0

Mode	∑ MPE max ratios	Limit	Results
2.4G WIFI + LTE	0.12436	1.0	Pass

9. 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----------