Maximum Permissible Exposure Report

1. Product Information

Name of EUT	Cellular Wi-Fi Router
Test Model	H8951-NA
Additional Models	H8951, H8951-LQA
Model Declaration	PCB board, structure and internal of these models are the same, So no additional models were tested.
Power Supply	Input: 5-36V⎓1.5A
Hardware Version	V50A
Software Version	V7.2.0_SE_Techtrex
2.4G WLAN	
Frequency Range	2412 – 2462 MHz
Channel Number	11 Channels for 20MHz bandwidth (2412~2462MHz) 7 Channels for 40MHz bandwidth (2422~2452MHz)
Channel Spacing	5MHz
Modulation Type	IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM,QPSK,BPSK)
Antenna Description	External Antenna, 2.5dBi(Max.)
WCDMA	
UMTS Operation Frequency Band	UMTS FDD Band II/IV/V
WCDMA Release Version	R8
HSDPA Release Version	Release 8
HSUPA Release Version	Release 6
DC-HSUPA Release Version	Not Supported
Modulation Type	QPSK for UMTS
Antenna Gain	External Antenna, 2.5dBi(Max.)
LTE	
LTE Operation Frequency Band	LTE Band 2, 4, 5, 12, 13, 25, 26
LTE Release Version	Release 9
LTE/UMTS Power Class	Class 3
Modulation Type	QPSK, 16QAM for LTE
Antenna Gain	External Antenna, 2.5dBi(Max.)
Extreme temp. Tolerance	-20°C to +55°C
GPS function	Not Supported
FM function	Not Supported
NFC Function	Not Supported
Extreme vol. Limits	Extreme vol 1：4.25VDC to 5.75VDC (nominal: 5VDC) Extreme vol 2：30.6VDC to 41.4VDC (nominal: 36VDC)
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
External Antenna	600 MHz – 3000 MHz	2.5 dBi	WIFI/WCDMA/LTE Main ANT
External Antenna	600 MHz – 3000 MHz	2.5 dBi	LTE Div ANT

6. Conducted Power

[2.4GWLAN Max Peak Conducted Power]

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
IEEE 802.11b	1	2412	8.75
	6	2437	8.63
	11	2462	8.40
IEEE 802.11g	1	2412	9.00
	6	2437	8.78
	11	2462	8.26
IEEE 802.11n HT20	1	2412	9.05
	6	2437	8.69
	11	2462	8.12
IEEE 802.11n HT40	3	2422	10.29
	6	2437	10.06
	9	2452	9.31

[WCDMA Max Average Power]

Test Mode	Channel	Frequency (MHz)	Max Average Power (dBm)
WCDMA Band II	Low	1852.4	22.98
	Middle	1880	22.98
	High	1907.6	22.95
WCDMA Band IV	Low	1712.4	23.00
	Middle	1732.6	22.99
	High	1752.6	22.97
WCDMA Band V	Low	826.4	23.01
	Middle	836.4	23.02
	High	846.6	22.94

[LTE Max Average Power]

Test Mode		Channel	Max Average Power (dBm)
LTE	Band 2	LCH	23.34
		MCH	23.90
		HCH	23.56
	Band 4	LCH	23.36
		MCH	23.53
		HCH	23.34
	Band 5	LCH	24.67
		MCH	24.23
		HCH	24.60
	Band 12	LCH	23.22
		MCH	24.01
		HCH	24.96
	Band 13	LCH	24.19
		MCH	24.69
		HCH	24.71
	Band 25	LCH	24.25
		MCH	24.28
		HCH	23.28
	Band 26 (814-824MHz)	LCH	22.84
		MCH	22.57
		HCH	23.34
	Band 26 (824-849MHz)	LCH	23.54
		MCH	24.05
		HCH	24.20

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	8.75	9.0±1.0
	MCH	8.63	9.0±1.0
	HCH	8.40	9.0±1.0
IEEE 802.11g	LCH	9.00	9.0±1.0
	MCH	8.78	9.0±1.0
	HCH	8.26	9.0±1.0
IEEE 802.11n HT20	LCH	9.05	9.0±1.0
	MCH	8.69	9.0±1.0
	HCH	8.12	9.0±1.0
IEEE 802.11n HT40	LCH	10.29	10.0±1.0
	MCH	10.06	10.0±1.0
	HCH	9.31	10.0±1.0

[WCDMA Max Average Power]

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
WCDMA	Band II	LCH	22.98	23.0±1.0
		MCH	22.98	23.0±1.0
		HCH	22.95	23.0±1.0
	Band IV	Low	23.00	23.0±1.0
		Middle	22.99	23.0±1.0
		High	22.97	23.0±1.0
	Band V	LCH	23.01	23.0±1.0
		MCH	23.02	23.0±1.0
		HCH	22.94	23.0±1.0

<LTE Max Average Power>

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 2	LCH	23.34	23.0±1.0
		MCH	23.90	23.0±1.0
		HCH	23.56	23.0±1.0
	Band 4	LCH	23.36	23.0±1.0
		MCH	23.53	23.0±1.0
		HCH	23.34	23.0±1.0
	Band 5	LCH	24.67	24.0±1.0
		MCH	24.23	24.0±1.0
		HCH	24.60	24.0±1.0
	Band 12	LCH	23.22	24.0±1.0
		MCH	24.01	24.0±1.0
		HCH	24.96	24.0±1.0
	Band 13	LCH	24.19	24.0±1.0
		MCH	24.69	24.0±1.0
		HCH	24.71	24.0±1.0
	Band 25	LCH	24.25	24.0±1.0
		MCH	24.28	24.0±1.0
		HCH	23.28	24.0±1.0
	Band 26 (814-824MHz)	LCH	22.84	23.0±1.0
		MCH	22.57	23.0±1.0
		HCH	23.34	23.0±1.0
	Band 26 (824-849MHz)	LCH	23.54	24.0±1.0
		MCH	24.05	24.0±1.0
		HCH	24.20	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	10.0	10	2.5	1.78	0.004	1.0
IEEE 802.11g	10.0	10	2.5	1.78	0.004	1.0
IEEE 802.11n HT20	10.0	10	2.5	1.78	0.004	1.0
IEEE 802.11n HT40	11.0	12.59	2.5	1.78	0.005	1.0

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm2)	MPE Limits (mW/cm2)
	dBm	mW				
WCDMA Band II	24.0	251.19	2.5	1.78	0.089	1.0
WCDMA Band IV	24.0	251.19	2.5	1.78	0.089	1.0
WCDMA Band V	24.0	251.19	2.5	1.78	0.089	0.55
LTE Band 2	24.0	251.19	2.5	1.78	0.089	1.0
LTE Band 4	24.0	251.19	2.5	1.78	0.089	1.0
LTE Band 5	25.0	316.23	2.5	1.78	0.112	0.55
LTE Band 12	25.0	316.23	2.5	1.78	0.112	0.47
LTE Band 13	25.0	316.23	2.5	1.78	0.112	0.52
LTE Band 25	25.0	316.23	2.5	1.78	0.112	1.0
LTE Band 26 (814-824MHz)	24.0	251.19	2.5	1.78	0.089	0.54
LTE Band 26 (824-849MHz)	25.0	316.23	2.5	1.78	0.112	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 transmit antenna of 2.4G WLAN and WCDMA&LTE is the same one, but there are two antenna ports, one is for 2.4G WLAN and the other is for LTE&WCDMA. So 2.4G WLAN&WCDMA and 2.4G WLAN&LTE can transmit at the same time.
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&WCDMA	0.167	1.0	Pass
2.4G WIFI&LTE	0.243	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----------