Maximum Permissible Exposure Report

1. Product Information

FCC ID	2AK7X-HS1GW-E-2
Product name	Smart Gateway
Model number	HS1GW-E-2, HS1GW-E-2W
Model Declaration	PCB board, structure and internal of these model(s) are the same, so no additional models were tested
Test Model	HS1GW-E-2
Power supply	DC 5.0V
2.4G WLAN	Supports IEEE 802.11b/802.11g/802.11n
Operation frequency	IEEE 802.11b:2412-2462MHz IEEE 802.11g:2412-2462MHz IEEE 802.11n HT20:2412-2462MHz IEEE 802.11n HT40:2422-2452MHz
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)
Channel Number	11 Channels for WIFI 20MHz Bandwidth (IEEE 802.11b/g/n HT20) 7 Channels for WIFI 40MHz Bandwidth (IEEE 802.11n HT40)
Antenna Type	PCB antenna
Antenna Gain	2.0dBi (Max.)
Hardware version	V01
Software version	V1.6.0
ZigBee Technology	
Operation frequency	2405MHz-2480MHz
Modulation Type	O-QPSK
Channel Number	16 channels
Channel Spacing	5MHz
Antenna Type	PCB Antenna
Antenna Gain	1.78dBi (Max.)
Extreme temp. Tolerance	-10°C to +50°C
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

The EUT can only use antennas certificated as follows provided by manufacturer;

External Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain
Antenna 0	Internal Antenna	600 MHz – 2500 MHz	2.0dBi (max.) For 2.4G WLAN
Antenna 1	Internal Antenna	600 MHz – 2500 MHz	1.78dBi (max.) For ZigBee

Note: Antenna 0 is 2.4GWLAN antenna, and antenna 1 is ZigBee antenna.

6. Conducted Power

General Note:
1. Per KDB 447498 D01v06, the maximum output power channel is used for SAR testing, further SAR test reduction and MPE.

<2.4GWLAN Max Conducted Power>

Test Mode		Channel	Frequency (MHz)	Max Conducted Power (dBm)
2.4GWLAN	IEEE 802.11b	LCH	2412	18.65
		MCH	2437	18.77
		HCH	2462	18.62
	IEEE 802.11g	LCH	2412	18.33
		MCH	2437	18.15
		HCH	2462	18.24
	IEEE 802.11n HT20	LCH	2412	17.32
		MCH	2437	17.59
		HCH	2462	17.66
	IEEE 802.11n HT40	LCH	2422	16.32
		MCH	2437	16.89
		HCH	2452	16.78

<ZigBee Max Conducted Power>

Test Mode	Channel	Frequency (MHz)	Max Conducted Power (dBm)
ZigBee	LCH	2405	6.160
	MCH	2440	5.793
	HCH	2480	5.327

7. Manufacturing Tolerance

<2.4GWLAN>

Test Mode		Channel	Max Conducted Power (dBm)	ANT Max. Tune Up Power (dBm)
2.4GWLAN	IEEE 802.11b	LCH	18.65	18.0±1.0
		MCH	18.77	18.0±1.0
		HCH	18.62	18.0±1.0
	IEEE 802.11g	LCH	18.33	18.0±1.0
		MCH	18.15	18.0±1.0
		HCH	18.24	18.0±1.0
	IEEE 802.11n HT20	LCH	17.32	17.0±1.0
		MCH	17.59	17.0±1.0
		HCH	17.66	17.0±1.0
	IEEE 802.11n HT40	LCH	16.32	16.0±1.0
		MCH	16.89	16.0±1.0
		HCH	16.78	16.0±1.0

<ZigBee>

Test Mode	Channel	Max Conducted Power (dBm)	ANT Max. Tune Up Power (dBm)
ZigBee	LCH	6.160	6.0±1.0
	MCH	5.793	5.0±1.0
	HCH	5.327	5.0±1.0

8. Measurement Results

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

Antenna 0

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11b	19.00	79.4328	2.0000	1.5849	0.0250	1.0000
IEEE 802.11g	19.00	79.4328	2.0000	1.5849	0.0250	1.0000
IEEE 802.11n HT20	18.00	63.0957	2.0000	1.5849	0.0199	1.0000
IEEE 802.11n HT40	17.00	50.1187	2.0000	1.5849	0.0158	1.0000

Antenna 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
ZigBee	7.00	5.0119	1.7800	1.5066	0.0015	1.0000

Remark:
1. Output power including turn-up tolerance;
2. Output power is burst average power;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer;
4. MPE values = $PG/4\pi R^2$

8.2 Simultaneous Transmission MPE

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

2.4G WLAN+ZigBee			
Mode	∑ MPE ratios	Limit	Results
IEEE 802.11b + ZigBee	0.0265	1.000	Pass
IEEE 802.11g + ZigBee	0.0265	1.000	Pass
IEEE 802.11n20 + ZigBee	0.0214	1.000	Pass
IEEE 802.11n40 + ZigBee	0.0173	1.000	Pass

9. Conclusion

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

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