

Maximum Permissible Exposure Report

1. Product Information

FCC ID:	SM6-SH-GW-V4	
Product name	Smart Hydrant Solutions	
Model number	Gateway Generation 4	
Power supply	DC 3.6V battery powered	
Modulation Type	GFSK for Bluetooth LE QPSK and 16QAM for LTE	
Antenna Type	Bluetooth: PIFA Antenna LTE : PIFA Antenna	
Antenna Gain	3.8dBi (max.) For LTE(Band 2/4/25/66); 3.5dBi (max.) For LTE(Band 5/12/13/26); 1.1dBi (max.) For Bluetooth LE	
Hardware version	870-xxx-001	
Software version	sh_gateway_newage_2.8.0-a	
LTE Operation Frequency Band	Band 2: 1850MHz-1910MHz(TX)	1930MHz-1990MHz(RX)
	Band 4: 1710MHz-1755MHz(TX)	2110MHz-2155MHz(RX)
	Band 5: 824MHz-849MHz(TX)	869MHz-894MHz(RX)
	Band 12: 699MHz-716MHz(TX)	729MHz-746MHz(RX)
	Band 13: 777MHz-787MHz(TX)	746MHz-756MHz(RX)
	Band 25: 1850MHz-1915MHz(TX)	1930MHz-1995MHz(RX)
	Band 26: 814MHz-849MHz(TX)	859MHz-894MHz(RX)
	Band 66: 1710MHz-1780MHz(TX)	2110MHz-2200MHz(RX)
Extreme temp. Tolerance	-20°C to +60°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
Bluetooth Antenna	PIFA Antenna	600 MHz – 2500 MHz	1.1dBi (max.) For Bluetooth LE
LTE Antenna	PIFA Antenna	600 MHz – 2500 MHz	3.8dBi (max.) For LTE(Band 2/4/25/66); 3.5dBi (max.) For LTE(Band 5/12/13/26);

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.

< Bluetooth LE Max Conducted Power >

Test Mode	Channel	Frequency (MHz)	Max Conducted Power (dBm)
Bluetooth LE-1M	LCH	2402	5.17
	MCH	2440	5.69
	HCH	2480	5.53
Bluetooth LE-2M	LCH	2402	5.32
	MCH	2440	5.73
	HCH	2480	5.49

<LTE Max Conducted Power>

Test Mode		Modulation	Max Conducted Power (dBm)
LTE	Band 2	QPSK	27.66
		16QAM	27.52
	Band 4	QPSK	26.90
		16QAM	26.72
	Band 5	QPSK	21.80
		16QAM	21.77
	Band 12	QPSK	21.83
		16QAM	21.96
	Band 13	QPSK	22.00
		16QAM	22.06
	Band 25	QPSK	27.50
		16QAM	27.64
	Band 26	QPSK	22.06
		16QAM	22.05
	Band 66	QPSK	26.55
		16QAM	26.74

7. Manufacturing Tolerance

< Bluetooth LE >

Test Mode	Channel	Max Conducted Power (dBm)	ANT Max. Tune Up Power (dBm)
Bluetooth LE-1M	LCH	5.17	5.0±1.0
	MCH	5.69	6.0±1.0
	HCH	5.53	6.0±1.0
Bluetooth LE-2M	LCH	5.32	5.0±1.0
	MCH	5.73	6.0±1.0
	HCH	5.49	5.0±1.0

<LTE Max Conducted Power>

Test Mode		Max Conducted Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 2	27.66	28.0±1.0
		27.52	28.0±1.0
	Band 4	26.90	27.0±1.0
		26.72	27.0±1.0
	Band 5	21.80	22.0±1.0
		21.77	22.0±1.0
	Band 12	21.83	22.0±1.0
		21.96	22.0±1.0
	Band 13	22.00	22.0±1.0
		22.06	22.0±1.0
	Band 25	27.50	28.0±1.0
		27.64	28.0±1.0
	Band 26	22.06	22.0±1.0
		22.05	22.0±1.0
	Band 66	26.55	27.0±1.0
		26.74	27.0±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, $r = 20\text{cm}$, 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				
Bluetooth LE-1M	7.0	5.0119	1.1	1.2882	0.0013	1.0000
Bluetooth LE-2M	7.0	5.0119	1.1	1.2882	0.0013	1.0000

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
LTE Band 2	29.0	794.3282	3.8	2.3988	0.3791	1.0000
LTE Band 4	28.0	630.9573	3.8	2.3988	0.3011	1.0000
LTE Band 5	23.0	199.5262	3.5	2.2387	0.0889	0.5493
LTE Band 12	23.0	199.5262	3.5	2.2387	0.0889	0.4660
LTE Band 13	23.0	199.5262	3.5	2.2387	0.0889	0.5180
LTE Band 25	29.0	794.3282	3.8	2.3988	0.3791	1.0000
LTE Band 26	23.0	199.5262	3.5	2.2387	0.0889	1.0000
LTE Band 66	28.0	630.9573	3.8	2.3988	0.3011	1.0000

Remark:

1. Output power (Average) 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 Bluetooth 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;
 $\sum \sum$ of MPE ratios ≤ 1.0

Bluetooth +LTE			
Mode	\sum MPE ratios	Limit	Results
Bluetooth + LTE Band 2	0.3804	1.000	Pass
Bluetooth + LTE Band 4	0.3024	1.000	Pass
Bluetooth + LTE Band 5	0.0902	1.000	Pass
Bluetooth + LTE Band 12	0.0902	1.000	Pass
Bluetooth + LTE Band 13	0.0902	1.000	Pass
Bluetooth + LTE Band 25	0.3804	1.000	Pass
Bluetooth + LTE Band 26	0.0902	1.000	Pass
Bluetooth + LTE Band 66	0.3024	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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