

FCC RF Exposure Evaluation

1. Product Information

FCC ID	2BEL9-S55
Product Name	Clean robot
Test Model	S55
Power Supply	Charging pile: Input: 100-240V~, 50/60Hz, 1.5A Output: 25.6V---40Ah MAX
Modulation Type	DSSS, OFDM
Antenna Type	Ant 1: PIFA Antenna Ant 2: PIFA Antenna
Antenna Gain	Ant 1: 2.5dBi Ant 2: 2.5dBi MIMO(Antenna 1+Antenna 2) Directional Gain (dBi): 5.5 dBi
Frequency Range	2412MHz~2462MHz,5180MHz~5240MHz
Exposure Category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

2. Evaluation Method and Limit

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

4. 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 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

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

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

100043851 can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Note
PIFA Antenna	2412 MHz-2462 MHz 5180 MHz-5240 MHz	Ant 1: 2.5dBi Ant 2: 2.5dBi	WLAN Antenna

6. Conducted Power Results

2.4G WiFi

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)		
			ANT1	ANT2	MIMO
802.11b	1	2412	9.80	10.15	/
	6	2437	10.28	10.56	/
	11	2462	10.03	10.40	/
802.11g	1	2412	13.04	12.76	/
	6	2437	13.43	13.10	/
	11	2462	13.02	12.74	/
802.11n (HT20)SISO	1	2412	12.82	12.51	/
	6	2437	13.46	13.14	/
	11	2462	12.97	12.57	/
802.11n (HT40) SISO	3	2412	14.78	13.87	/
	6	2437	13.27	14.92	/
	9	2462	13.43	13.08	/
802.11n (HT20)MIMO	1	2412	12.04	12.38	15.22
	6	2437	12.20	13.07	15.67
	11	2462	11.58	12.40	15.02
802.11n (HT40)MIMO	3	2412	14.08	13.17	16.66
	6	2437	13.74	13.20	16.49
	9	2462	13.62	12.72	16.20

5.2G WiFi

Mode	TX Type	Frequency (MHz)	Peak Conducted Output Power (dBm)		
			ANT1	ANT2	MIMO
802.11a	SISO	5180	10.65	11.01	/
		5200	10.37	11.10	/
		5240	13.01	10.72	/
802.11n (HT20)	SISO	5180	12.17	11.13	/
		5200	11.46	10.96	/
		5240	9.89	10.97	/
802.11n (HT40)	SISO	5190	11.57	11.15	/
		5230	10.39	10.97	/
802.11n (HT20)	MIMO	5200	12.25	10.98	14.67
		5240	11.42	11.18	14.31
		5190	9.92	11.03	13.52
802.11n (HT40)	MIMO	5230	12.00	11.10	14.58
		5180	10.50	12.31	14.51
802.11ac (VHT20)	SISO	5240	12.17	10.86	/
		5190	11.24	11.27	/
		5230	9.92	11.09	/
802.11ac (VHT40)	SISO	5210	8.29	11.08	/
		5180	8.71	11.57	/
802.11ac (VHT80)	SISO	5240	14.98	11.39	/
802.11ac (VHT20)	MIMO	5210	13.64	11.46	15.70
		5180	13.30	11.30	15.42
		5200	13.58	10.82	15.43
802.11ac (VHT40)	MIMO	5240	10.93	11.30	14.13
		5180	10.72	11.28	14.02
802.11ac (VHT80)	MIMO	5240	12.72	11.16	15.02

7.Manufacturing Tolerance

2.4GWiFi >

802.11b (Peak)			
Channel	Channel1	Channel 6	Channel 11
Target (dBm)	10	11	10
Tolerance ±(dB)	1.0	1.0	1.0
802.11g (Peak)			
Channel	Channel1	Channel 6	Channel 11
Target (dBm)	13	13	13
Tolerance ±(dB)	1.0	1.0	1.0
802.11n(HT20) (Peak)			
Channel	Channel1	Channel 6	Channel 11
Target (dBm)	15	16	15
Tolerance ±(dB)	1.0	1.0	1.0
802.11n(HT40) (Peak)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	17	16	16
Tolerance ±(dB)	1.0	1.0	1.0

5.2GWiFi >

802.11a (Peak)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	11	11	13
Tolerance ±(dB)	1.0	1.0	1.0
802.11n(HT20) (Peak)			
Channel	Channel36	Channel40	Channel 48
Target (dBm)	15	14	14
Tolerance ±(dB)	1.0	1.0	1.0
802.11n(HT40) (Peak)			
Channel	Channel 38	Channel 46	
Target (dBm)	15	15	
Tolerance ±(dB)	1.0	1.0	
802.11ac(HT20) (Peak)			
Channel	Channel1	Channel 6	Channel 11
Target (dBm)	16	15	15
Tolerance ±(dB)	1.0	1.0	1.0
802.11ac(HT40) (Peak)			
Channel	Channel 38	Channel 46	
Target (dBm)	14	14	
Tolerance ±(dB)	1.0	1.0	
802.11ac(HT80) (Peak)			
Channel	Channel 42		
Target (dBm)	15		
Tolerance ±(dB)	1.0		

8. Evaluation 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.

2.4GWiFi

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
802.11b	12	15.85	5.5	3.5481	100%	0.0112	1.0000
802.11g	14	25.12	5.5	3.5481	100%	0.0177	1.0000
802.11n(HT20)	17	50.12	5.5	3.5481	100%	0.0354	1.0000
802.11n(HT40)	18	63.10	5.5	3.5481	100%	0.0445	1.0000

5.2GWiFi

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
802.11a	14	25.12	5.5	3.5481	100%	0.0177	1.0000
802.11n(HT20)	16	39.81	5.5	3.5481	100%	0.0281	1.0000
802.11n(HT40)	16	39.81	5.5	3.5481	100%	0.0281	1.0000
802.11ac(HT20)	17	50.12	5.5	3.5481	100%	0.0354	1.0000
802.11ac(HT40)	15	31.6228	5.5	3.5481	100%	0.0223	1.0000
802.11ac(HT80)	16	39.8107	5.5	3.5481	100%	0.0281	1.0000

Remark:

1. Output power including tune-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer;

8.2 Simultaneous Transmission MPE

The sample supports two modules and two antennas, Need to consider simultaneous transmission;

Simultaneous transmission MPE

2.4G WIFI MPE (mW/cm ²)	5.2G WiFi MPE (mW/cm ²)	Max.sum of the MPE ratios	Limit	Test Results
0.0445	0.0354	0.799	1	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.....