

RF Exposure evaluation

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1. Applicable Standard

According to §1.1307(b)(1), systems operating under the provisions of this 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.

According to §1.1310 and §2.1091 RF exposure is calculated.

KDB447498 v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

According to section 2.5.1 of RSS-102, RF exposure requirement.

2. 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 modeled 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.

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

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz⁶ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $22.48/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

Quick Fact

MHz	EIRP (W)	EIRP (dBm)
920	1.39	31.43
850	1.32	31.19
2450	2.71	34.33
1900	2.28	33.58
5200	4.54	36.57

3. Conducted Power Results

Antenna 1

Mode	Channel	Frequency (MHz)	Worst case Data rate	Conducted Output Power (dBm)	
				PK	Average
802.11b	01	2412	1Mbps	15.84	12.76
	06	2437	1Mbps	15.63	12.58
	11	2462	1Mbps	15.45	12.34
802.11g	01	2412	6Mbps	14.75	11.83
	06	2437	6Mbps	14.82	11.27
	11	2462	6Mbps	14.27	11.62
802.11n HT20	01	2412	6.5 Mbps	14.65	11.27
	06	2437	6.5 Mbps	14.34	11.34
	11	2462	6.5 Mbps	14.17	11.15
802.11n HT40	03	2422	6.5 Mbps	12.81	8.23
	06	2437	6.5 Mbps	12.36	8.64
	09	2452	6.5 Mbps	12.42	8.51

Antenna 2

Mode	Channel	Frequency (MHz)	Worst case Data rate	Conducted Output Power (dBm)	
				PK	Average
802.11b	01	2412	1Mbps	15.42	12.53
	06	2437	1Mbps	15.35	12.62
	11	2462	1Mbps	15.67	12.45
802.11g	01	2412	6Mbps	14.27	11.46
	06	2437	6Mbps	14.15	11.34
	11	2462	6Mbps	14.36	11.51
802.11n HT20	01	2412	6.5 Mbps	14.45	11.42
	06	2437	6.5 Mbps	14.14	11.28
	11	2462	6.5 Mbps	14.02	11.24
802.11n HT40	03	2422	6.5 Mbps	12.64	8.35
	06	2437	6.5 Mbps	12.57	8.33
	09	2452	6.5 Mbps	12.34	8.42

Manufacturing tolerance

Antenna 1

IEEE 802.11b (Average)			
Frequency	2412	2437	2462
Target (dBm)	12	12	12
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11g (Average)			
Frequency	2412	2437	2462
Target (dBm)	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Frequency	2412	2437	2462
Target (dBm)	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Frequency	2422	2437	2452
Target (dBm)	8	8	8
Tolerance $\pm$ (dB)	1.0	1.0	1.0

Antenna 2

IEEE 802.11b (Average)			
Frequency	2412	2437	2462
Target (dBm)	12	12	12
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11g (Average)			
Frequency	2412	2437	2462
Target (dBm)	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Frequency	2412	2437	2462
Target (dBm)	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Frequency	2422	2437	2452
Target (dBm)	8	8	8
Tolerance $\pm$ (dB)	1.0	1.0	1.0

MIMO

IEEE 802.11n HT20 (Average)			
Frequency	2412	2437	2462
Target (dBm)	14.01	14.01	14.01
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Frequency	2422	2437	2452
Target (dBm)	11.01	11.01	11.01
Tolerance ±(dB)	1.0	1.0	1.0

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. Result

Mode	Frequency (MHz)	Antenna Distance (mm)	RF output power (including tune-up tolerance) dBm	Antenna Gain (dBi)	E.I.R.P (dBm)	E.I.R.P (w)	SAR Test Exclusion Threshold (w)	SAR Test Exclusion
WLAN	2412	20.00	15.01	1.24	16.25	0.0422	2.684	Yes

Mode	Minimum Separation Distance (cm)	Output Power (Turn-up Procedure)		Antenna Gain (Numeric)	Power Density At 20 cm (mW/cm²)	Power Density Limit (mW/cm²)	Test Results
		dBm	mW				
WLAN	20.00	15.01	31.6957	1.3305	0.0084	1.0000	PASS

6. Simultaneous transmission MPE Considerations

According to KDB447498 :For mobile exposure host platform to qualify for simultaneous transmission MPE test exclusion, all transmitters and antennas in the host must be either evaluated for MPE compliance, by measurement or computational modeling, or qualify for the standalone MPE test exclusion in section 7.1.

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 modeled or measured field strengths or power density, is ≤ 1.0 .

This means that:

$\sum$ of MPE ratios ≤ 1.0

The EUT is Not Applicable.

7. Conclusion

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and section 2.5.1 of RSS-102, SAR Exclusion Threshold.