

Maximum Permissible Exposure (MPE)

Standard Applicable

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

RSS 102 issue 5.

This is a Mobile device, the MPE is required.

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

Limits for Maximum Permissible Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

F = frequency in MHz,

* = Plane-wave equipment power density

RSS 102 Issue 5 Mar. 2015

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

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).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Tune-Up Power and Tolerance:

RF power setting in TEST SoftWare for FCC

2.4G	802.1 1b	802.11g		802.11n20 Ant0	802.11n20 Ant1	802.11n40 Ant0	802.11n40 Ant1
Low	15	12		7	7	6	7
Mid	16	17		18	18	20	21
High	18	14		12	12	10	11
5G B1	802.1 1a	802.11HT20 Ant0	802.11HT20 Ant1	802.11HT40 Ant0	802.11HT40 Ant1	802.11AC80 Ant0	802.11AC80 Ant1
Low	33	30	31	25	25		
Mid	34	31	32	25	25	23	22
High	34	32	33	25	25		
5G B4	802.1 1a	802.11HT20 Ant0	802.11HT20 Ant1	802.11HT40 Ant0	802.11HT40 Ant1	802.11AC80 Ant0	802.11AC80 Ant1
Low	25	20	21	17	18		
Mid	26	20	21	17	18	20	21
High	25	21	21	17	18		

Measured Power Level for FCC

Wi-Fi	Frequency Range (MHz)	Channels	Peak / Average Rated Power	Modulation Technology
802.11b	2412 – 2462(DTS)	11	23.5dBm (PK)	DSSS
802.11g	2412 – 2462(DTS)	11	24.52dBm (PK)	OFDM
802.11n (2.4G)	HT20 2412 – 2462(DTS)	11	27.42dBm (PK)	
	HT40 2422 – 2452(DTS)	7	27.35dBm (PK)	
802.11a	5180 – 5240(NII)	4	17.88dBm (AV)	
	5745 – 5825(NII)	5	12.93dBm (AV)	
802.11n(5G)	HT20, 5180 – 5240(NII)	4	15.66dBm (AV)	
	HT20, 5745 – 5825(NII)	5	9.44dBm (AV)	
	HT40, 5190 – 5230(NII)	3	11.27dBm (AV)	
	HT40, 5755 – 5815(NII)	4	6.58dBm (AV)	
802.11ac	HT80, 5210(NII)	1	9.56dBm (AV)	
	HT80, 5775(NII)	1	6.13dBm (AV)	
Modulation type		CCK, DQPSK, DBPSK for DSSS 256QAM.64QAM. 16QAM, QPSK, BPSK for OFDM		
Antenna Designation		WiFi: Fixed PIFA Antenna WLA-EM-1607-0051-B: 2.4GHz: 3.12dBi; 5GHz: 6.14dBi WLA-EM-1607-0050-B: 2.4GHz: 1.94dBi; 5GHz: 2.62dBi According to KDB662911 D01 SM-MIMO signals could be considered uncorrelated for purposes of directional gain computation. Directional gain = GANT		

The EUT is compliance with IEEE 802.11 a/b/g/n/ac Standard.

Tune-Up power Tolerance: 1

RF power setting in TEST SoftWare for IC

2.4G	802.1 1b	802.11g		802.11n20 Ant0	802.11n20 Ant1	802.11n40 Ant0	802.11n40 Ant1
Low	15	12		7	7	6	7
Mid	16	17		18	18	20	21
High	18	14		12	12	10	11
5G B1	802.1 1a	802.11HT20 Ant0	802.11HT20 Ant1	802.11HT40 Ant0	802.11HT40 Ant1	802.11AC80 Ant0	802.11AC80 Ant1
Low	19	16	17	20	20		
Mid	20	17	18	20	20	23	22
High	20	17	18	20	20		
5G B4	802.1 1a	802.11HT20 Ant0	802.11HT20 Ant1	802.11HT40 Ant0	802.11HT40 Ant1	802.11AC80 Ant0	802.11AC80 Ant1
Low	25	20	21	17	18		
Mid	26	20	21	17	18	20	21
High	25	21	21	17	18		

Measured Power Level for IC

Wi-Fi	Frequency Range (MHz)	Channels	Peak / Average Rated Power	Modulation Technology
802.11b	2412 – 2462(DTS)	11	23.5dBm (PK)	DSSS
802.11g	2412 – 2462(DTS)	11	24.52dBm (PK)	OFDM
802.11n (2.4G)	HT20 2412 – 2462(DTS)	11	27.42dBm (PK)	
	HT40 2422 – 2452(DTS)	7	27.35dBm (PK)	
802.11a	5180 – 5240(NII)	4	14.73 dBm EIRP (AV)	
	5745 – 5825(NII)	5	12.93dBm (AV)	
802.11n(5G)	HT20, 5180 – 5240(NII)	4	14.91 dBm EIRP (AV)	
	HT20, 5745 – 5825(NII)	5	9.44dBm (AV)	
	HT40, 5190 – 5230(NII)	3	16.39 dBm EIRP (AV)	
	HT40, 5755 – 5815(NII)	4	6.58dBm (AV)	
802.11ac	HT80, 5210(NII)	1	17.17 dBm EIRP (AV)	
	HT80, 5775(NII)	1	6.13dBm (AV)	
Modulation type		CCK, DQPSK, DBPSK for DSSS 256QAM.64QAM. 16QAM, QPSK, BPSK for OFDM		
Antenna Designation		WiFi: Fixed PIFA Antenna WLA-EM-1607-0051-B: 2.4GHz: 3.12dBi; 5GHz: 6.14dBi WLA-EM-1607-0050-B: 2.4GHz: 1.94dBi; 5GHz: 2.62dBi According to KDB662911 D01 SM-MIMO signals could be considered uncorrelated for purposes of directional gain computation. Directional gain = GANT		

The EUT is compliance with IEEE 802.11 a/b/g/n/ac Standard.

Tune-Up power Tolerance: 1

Zigbee

Frequency Range(MHz)	2405-2480MHz
Modulation type	OQPSK
Channel Number	16
Antenna Designation:	PIFA Antenna / 2.7 dBi

The EUT is compliance with IEEE 802.11 a/b/g/n/ac Standard.

Zigbee is certified as FCC part15.249 and IC RSS 210, then it was not considered MPE issue.

FCC: 2.4GHz mode: 802.11 n mode

Maximum Permissible Exposure (MPE) Evaluation: The worst case of Average power

Power measurement: refer to Part15.247 and RSS 247 report for details.

AV 2*2 MIMO

Channel		Output Chain (dBm)		Combine Output Power (dBm)	Limit(dBm)	Result
		Chain A	chain B			
AN HT20	Low	15.09	15.01	18.06	30	Pass
	Mid	18.83	19.24	22.05	30	Pass
	High	16.51	15.64	19.11	30	Pass
AN HT40	Low	14.09	14.25	17.18	30	Pass
	Mid	19.1	19.88	22.52	30	Pass
	High	15.49	15.25	18.38	30	Pass

Power Tolerance: +/- 1 dBm

Prediction 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

	CH 1-11	
Tune-Up power at antenna input terminal:	22.52	(dBm)
Tune-Up power at antenna input terminal:	178.65	(mW)
Tune-Up power Tolerance:	1.00	dB
Duty cycle:	100.00	(%)
Maximum Pav :	224.91	(mW)
Antenna gain (typical):	3.12	(dBi)
Maximum antenna gain:	2.05	(numeric)
Prediction distance:	20.00	(cm)
MPE limit for uncontrolled exposure at prediction frequency:	1.00	(mW/cm ²)
Power density at predication frequency at 20 (cm) distance	0.0918	(mW/cm ²)

Measurement Result:

The worst power density is 0.0918 mW/cm² which is less than 1 mW/cm².

5150MHz – 5250MHz Mode:

Power measurement:

The worst case of Average power a mode: refer to FCC test report for detail measurement date.

AV power, 2*2 MIMO

Mode	Freq(MHz)	Output Chain (dBm)		Combine Output Power (dBm)	Limit(dBm)	Result
		Chain A	chain B			
N HT20	5180	15.112	13.897	17.56	29.86	Pass
	5220	15.587	14.275	17.99	29.86	Pass
	5240	15.66	14.573	18.16	29.86	Pass

Power Tolerance: +/- 1 dBm

Prediction 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

Maximum output power at antenna input terminal:	18.16	(dBm)
Maximum output power at antenna input terminal:	65.46361741	(mW)
Tune-Up power Tolerance:	1	dB
Duty cycle:	100	(%)
Maximum Pav :	82.4138115	(mW)
Antenna gain (typical):	6.14	(dBi)
Maximum antenna gain:	4.111497211	(numeric)
Prediction distance:	20	(cm)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.0674451	(mW/cm ²)

Result:

The predicted power density level at 20 cm is 0.0674 mW/cm². This is below the uncontrolled exposure limit of 1 mW/cm².

5725MHz – 5850MHz Mode:

Power measurement:

The worst case of Average power a mode: refer to FCC test report for detail measurement date.

Mode	Freq(MHz)	channel	Power (dBm)	limit(dBm)	result
802.11a	5745	149	12.23	29.86	pass
	5785	157	12.93	29.86	pass
	5825	165	12.21	29.86	pass

Power Tolerance: +/- 1 dBm

Prediction 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

Maximum output power at antenna input terminal:	12.93	(dBm)
Maximum output power at antenna input terminal:	19.63360277	(mW)
Tune-Up power Tolerance:	1	dB
Duty cycle:	100	(%)
Maximum Pav :	24.71724145	(mW)
Antenna gain (typical):	6.14	(dBi)
Maximum antenna gain:	4.111497211	(numeric)
Prediction distance:	20	(cm)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.0202279	(mW/cm ²)

Result:

The predicted power density level at 20 cm is 0.0202mW/cm². This is below the uncontrolled exposure limit of 1 mW/cm².

Simultaneous transmission mode

2.4GHz mode + (5150MHz – 5250MHz) Mode:

Prediction frequency:	2.4	(GHz)
Power density at predication frequency at 20 (cm)	0.0918	(mW/cm ²)

Prediction frequency:	5	(GHz)
Power density at predication frequency at 20 (cm)	0.0674	(mW/cm ²)
2.4GHz + 5GHz Power density at predication frequency at 20 (cm) distance	0.1592000	(mW/cm ²)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)

The predicted power density level at 20 cm is 0.1592mW/cm². This is below the uncontrolled exposure limit of 1 mW/cm².

Simultaneous transmission mode

2.4GHz mode + (5725MHz – 5850MHz) Mode:

Prediction frequency:	2.4	(GHz)
Power density at predication frequency at 20 (cm)	0.0918000	(mW/cm ²)

Prediction frequency:	5	(GHz)
Power density at predication frequency at 20 (cm)	0.0202	(mW/cm ²)
2.4GHz + 5GHz Power density at predication frequency at 20 (cm) distance	0.1120000	(mW/cm ²)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)

Result:

The predicted power density level at 20 cm is 0.112 mW/cm². This is below the uncontrolled exposure limit of 1 mW/cm².

IC EIRP/Conducted Power level: 2.4GHz, 802.11 b mode

	2400-2483.5 2462	MHz MHz
Tune-UP power at antenna input terminal:	22.52	(dBm)
Tune-Up power Tolerance:	1	dB
Duty cycle:	100	(%)
Antenna gain (typical):	3.12	(dBi)
Conducted Power:	224.905	mW
Conducted Power:	0.22491	W
EIRP:	461.318	mW
EIRP:	0.46132	W
EIRP Limit	2.722	W

IC EIRP/Conducted Power level: 5150-5250MHz mode

	5150-5250 5210	MHz MHz
Tune-UP power at antenna input terminal:	11.03	(dBm)
Tune-Up power Tolerance:	1	dB
Duty cycle:	100	(%)
Antenna gain (typical):	6.14	(dBi)
Conducted Power:	15.959	mW
Conducted Power:	0.01596	W
EIRP:	65.615	mW
EIRP:	0.06561	W
EIRP Limit	4.543	W

IC EIRP/Conducted Power level: 5725-5850MHz, 802.11 an mode

	5725-5850 5785	MHz MHz
Tune-UP power at antenna input terminal:	12.93	(dBm)
Tune-Up power Tolerance:	1	dB
Duty cycle:	100	(%)
Antenna gain (typical):	6.14	(dBi)
Conducted Power:	24.717	mW
Conducted Power:	0.02472	W
EIRP:	101.625	mW
EIRP:	0.10162	W
EIRP Limit	4.880	W

Measurement Result:

The Conducted Power level is 0.4613W which less than RSS102 section 2.5.2 Exemption Limits (2.722W) above 300 MHz and below 6 GHz condition .

~~ End ~~