

RF Exposure Evaluation

Limits

The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in 1.1307(b)

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 (minutes)
(A) Limits for Occupational/Controlled Exposures				
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
(B) 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
1500–100,000			1.0	30

f = frequency in MHz

Friis transmission formula: $Pd = (Pout * G) / (4 * pi * r^2)$

Where

Pd = power density in mW/cm², **Pout** = output power to antenna in mW;

G = gain of antenna in linear scale, **Pi** = 3.1416;

R = distance between observation point and center of the radiator in cm

Pd id the limit of MPE, 1 mW/cm². If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

Test Procedure

Software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

Test Result of RF Exposure Evaluation

BT EDR

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
2402MHz	4.83	3.04	0.0017	1.0	PASS

BLE

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
2402MHz	-4.44	0.36	0.0002	1.0	PASS

Wifi 2.4G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
2452MHz MIMO 802.11n(HT40)	21.57	143.55	0.144	1.0	PASS
2452MHz ANT 1 802.11n(HT40)	19.18	82.79	0.034	1.0	PASS

Wifi 5.2G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5230 MHz MIMO 802.11AC(HT40)	15.22	33.27	0.048	1.0	PASS
5190MHz ANT 1 802.11AC(HT40)	13.47	22.23	0.012	1.0	PASS

Wifi 5.3G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5310MHz MIMO 802.11n (HT40)	15.20	33.11	0.046	1.0	PASS
5310MHz ANT 1 802.11AC (HT40)	14.34	27.16	0.014	1.0	PASS

Wifi 5.6G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5550MHz MIMO (802.11n HT40)	18.01	63.24	0.115	1.0	PASS
5530MHz ANT 1 (802.11AC HT80)	14.25	26.61	0.019	1.0	PASS

Wifi 5.8G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5795MHz MIMO 802.11n(HT40)	12.86	19.32	0.038	1.0	PASS
5755MHz ANT 1 802.11AC(HT40)	14.15	26.00	0.024	1.0	PASS

Simultaneous Transmission

Mode	BT	BLE	2.4G WIFI		5.2G WIFI		5.3G WIFI		5.6G WIFI		5.8G WIFI	
			SISO	MIMO	SISO	MIMO	SISO	MIMO	SISO	MIMO	SISO	MIMO
Output power (dBm)	4.83	-4.44	19.18	21.57	15.22	13.47	15.20	14.34	18.01	14.25	12.86	14.15
Output power (mW)	3.04	0.36	82.79	143.55	33.27	22.23	33.11	27.16	63.24	26.61	19.32	26.00
Antenna gain (dBi)	4.59	4.59	3.12	7.02	4.18	8.56	4.18	8.48	5.53	9.61	6.71	9.95
ERP (mW)	5.33	0.63	103.51	440.55	53.09	97.27	52.84	116.68	137.72	148.25	55.21	156.68
P_{th}/ERP_{th}	3060											
$\sum_{i=1}^a \frac{P_i}{P_{th,i}}$	BT +2.4G WIFI+UNII SISO						BT +2.4G WIFI+UNII MIMO					
	0.05						0.06					
$\sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}}$	BT +2.4G WIFI+UNII SISO						BT +2.4G WIFI+UNII MIMO					
	0.08						0.2					
$\sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k}$	BT +2.4G WIFI+UNII SISO						BT +2.4G WIFI+UNII MIMO					
	0.06						0.3					
$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k}$	BT +2.4G WIFI+UNII SISO						BT +2.4G WIFI+UNII MIMO					
	0.19						0.56					
Limit	1											

The max power density is less than MPE exempt limit, so it is compliance.