

RF Exposure Evaluation

Limits

According to KDB 447498 D01 General RF Exposure Guidance v06

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: $Pd = (P_{out} * G) / (4 * \pi * r^2)$

Where

Pd = power density in mW/cm², **P_{out}** = 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 is 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

	Modulation	Frequency MHz	Output power to antenna (dBm)	Max Output power to antenna (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
BR/EDR	GFSK	2402	5.89	3.881504	0.013615	1.0	PASS
		2441	5.32	3.404082	0.011941	1.0	PASS
		2480	5.55	3.589219	0.012590	1.0	PASS
	Π/4-DQPSK	2402	4.68	2.937650	0.010305	1.0	PASS
		2441	4.53	2.837919	0.009955	1.0	PASS
		2480	4.45	2.786121	0.009773	1.0	PASS
	8DPSK	2402	5.04	3.191538	0.011195	1.0	PASS
		2441	4.86	3.061963	0.010741	1.0	PASS
		2480	4.79	3.013006	0.010569	1.0	PASS
BLE(1M)	GFSK	2402	5.85	3.845918	0.013491	1.0	PASS
		2440	5.37	3.443499	0.012079	1.0	PASS
		2480	5.51	3.556313	0.012475	1.0	PASS
BLE(2M)	GFSK	2402	5.79	3.793150	0.013305	1.0	PASS
		2440	5.28	3.372873	0.011831	1.0	PASS
		2480	5.47	3.523709	0.012360	1.0	PASS
Wifi 2.4g	802.11b	2412	19.57	90.573260	0.317709	1.0	PASS
		2437	19.99	99.770006	0.349969	1.0	PASS
		2462	19.58	90.782053	0.318442	1.0	PASS
	802.11g	2412	18.17	65.614527	0.230160	1.0	PASS
		2437	18.04	63.679552	0.223373	1.0	PASS
		2462	18.86	76.913044	0.269793	1.0	PASS
	802.11n(20)	2412	18.20	66.069345	0.231755	1.0	PASS
		2437	18.81	76.032628	0.266704	1.0	PASS
		2462	18.10	64.565423	0.226480	1.0	PASS
	802.11n(40)	2422	16.74	47.206304	0.165588	1.0	PASS
		2437	16.79	47.752927	0.167506	1.0	PASS
		2452	16.17	41.399967	0.145221	1.0	PASS
	802.11ax (20)	2412	18.74	74.816950	0.262440	1.0	PASS
		2437	18.63	72.945751	0.255876	1.0	PASS
		2462	18.52	71.121351	0.249477	1.0	PASS
	802.11ax (40)	2422	16.01	39.902490	0.139968	1.0	PASS
		2437	16.53	44.977985	0.157772	1.0	PASS
		2452	16.09	40.644333	0.142571	1.0	PASS

	Modulation	Frequency (MHz)	Output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
Wifi5.2g	802.11a20	5180	13.63	23.067472	0.080729	1.0	PASS
		5200	15.81	38.106582	0.133361	1.0	PASS
		5240	16.11	40.831939	0.142899	1.0	PASS
	802.11n20	5180	15.60	36.307805	0.127066	1.0	PASS
		5200	15.68	36.982818	0.129428	1.0	PASS
		5240	16.56	45.289758	0.158500	1.0	PASS
	802.11ac20	5180	12.87	19.364220	0.067769	1.0	PASS
		5200	15.20	33.113112	0.115886	1.0	PASS
		5240	15.61	36.391504	0.127359	1.0	PASS
	802.11ax20	5180	13.53	22.542392	0.078891	1.0	PASS
		5200	16.39	43.551187	0.152416	1.0	PASS
		5240	16.87	48.640721	0.170228	1.0	PASS
	802.11n40	5190	12.56	18.030177	0.063100	1.0	PASS
		5240	16.10	40.738028	0.142571	1.0	PASS
	802.11ac40	5190	12.65	18.407720	0.064421	1.0	PASS
		5240	15.56	35.974934	0.125901	1.0	PASS
	802.11ax40	5190	13.93	24.717241	0.086503	1.0	PASS
		5240	16.44	44.055486	0.154181	1.0	PASS

	Modulation	Frequency (MHz)	Output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
Wifi5.3g	802.11a20	5260.00	15.68	36.982818	0.129428	1.0	PASS
		5300.00	16.73	47.097733	0.164828	1.0	PASS
		5320.00	16.12	40.926066	0.143229	1.0	PASS
	802.11n20	5260.00	15.57	36.057864	0.126191	1.0	PASS
		5300.00	15.66	36.812897	0.128834	1.0	PASS
		5320.00	15.27	33.651157	0.117769	1.0	PASS
	802.11ac20	5260.00	13.9	24.547089	0.085907	1.0	PASS
		5300.00	14.24	26.546056	0.092903	1.0	PASS
		5320.00	13.96	24.888573	0.087102	1.0	PASS
	802.11ax20	5260.00	12.94	19.678863	0.068870	1.0	PASS
		5300.00	12.61	18.238957	0.063831	1.0	PASS
		5320.00	13.16	20.701413	0.072449	1.0	PASS
	802.11n40	5270.00	14.86	30.619634	0.107159	1.0	PASS
		5310.00	12.83	19.186687	0.067148	1.0	PASS
	802.11ac40	5270.00	14.87	30.690220	0.107406	1.0	PASS
		5310.00	14.59	28.773984	0.100700	1.0	PASS
	802.11ax40	5270.00	13.31	21.428906	0.074995	1.0	PASS
		5310.00	13.53	22.542392	0.078891	1.0	PASS

	Modulation	Frequency (MHz)	Output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
Wifi5.6g	802.11a20	5500.00	13.75	23.713737	0.082991	1.0	PASS
		5600.00	12.66	18.450154	0.064570	1.0	PASS
		5700.00	12.80	19.054607	0.066685	1.0	PASS
	802.11n20	5500.00	13.88	24.434306	0.085513	1.0	PASS
		5600.00	13.33	21.527817	0.075341	1.0	PASS
		5700.00	12.36	17.218686	0.060260	1.0	PASS
	802.11ac20	5500.00	13.62	23.014418	0.080543	1.0	PASS
		5600.00	13.10	20.417379	0.071455	1.0	PASS
		5700.00	12.05	16.032454	0.056109	1.0	PASS
	802.11ax20	5500.00	13.67	23.280913	0.081476	1.0	PASS
		5600.00	12.43	17.498467	0.061239	1.0	PASS
		5700.00	12.11	16.255488	0.056889	1.0	PASS
	802.11n40	5510.00	14.22	26.424088	0.092476	1.0	PASS
		5590.00	12.60	18.197009	0.063684	1.0	PASS
		5670.00	12.74	18.793168	0.065770	1.0	PASS
	802.11ac40	5510.00	13.57	22.750974	0.079621	1.0	PASS
		5590.00	12.93	19.633603	0.068712	1.0	PASS
		5670.00	11.98	15.776113	0.055212	1.0	PASS
	802.11ax40	5510.00	11.75	14.962357	0.052364	1.0	PASS
		5590.00	11.77	15.031420	0.052605	1.0	PASS
		5670.00	12.15	16.405898	0.057416	1.0	PASS

	Modulation	Frequency (MHz)	Output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
Wifi5.8g	802.11a20	5745	12.45	17.579236	0.061522	1.0	PASS
		5785	12.63	18.323144	0.064125	1.0	PASS
		5825	12.29	16.943378	0.059297	1.0	PASS
	802.11n20	5745	13.3	21.379621	0.074822	1.0	PASS
		5785	12.96	19.769696	0.069188	1.0	PASS
		5825	12.77	18.923436	0.066226	1.0	PASS
	802.11ac20	5745	13.14	20.606299	0.072116	1.0	PASS
		5785	13.4	21.877616	0.076565	1.0	PASS
		5825	12.66	18.450154	0.064570	1.0	PASS
	802.11ax20	5745	13	19.952623	0.069828	1.0	PASS
		5785	13.48	22.284351	0.077988	1.0	PASS
		5825	12.74	18.793168	0.065770	1.0	PASS
	802.11n40	5755	11.23	13.273945	0.046455	1.0	PASS
		5795	11.07	12.793813	0.044774	1.0	PASS
	802.11ac40	5755	12.59	18.155157	0.063537	1.0	PASS
		5795	13.27	21.232445	0.074307	1.0	PASS
	802.11ax40	5755	11.47	14.028137	0.049094	1.0	PASS
		5795	11.18	13.121999	0.045923	1.0	PASS

Remark:

1. BT/wifi2.4g Antenna gain is 2.52 dBi, wifi5g Antenna gain is 2.51 dBi
2. In the case of simultaneous launches for wifi and BT:

The Max Calc. Thresholds :

BR/EDR:0.013615, BLE:0.013491 , Wifi2.4g: 0.349969 , Wifi5g:0.170228

BT and Wifi: $0.013615+0.013491+0.349969+0.170228 = 0.547303 \leq 1$

So a SAR test is not required