

RF Exposure Evaluation

According to KDB447498D01 General RF Exposure Guidance v06 4.3.1. Standalone SAR test exclusion considerations Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

Limits

According to FCC Part1.1310: 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 part1.1307(b)

TABLE 1—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 Formula

Friis transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$ Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

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

P_d is the limit of MPE. 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 Result of RF Exposure Evaluation

Antenna Gain: 5dBi, MIMO Gain: 8.01 dBi

Antenna Gain: The maximum Gain measured in fully anechoic chamber is 1.0 in linear scale.

Output Power Into Antenna & RF Exposure Evaluation Distance:

Measurement Data

The Max Conducted Peak Output Power data refer to report Report No.: ZKT-211012L5389-01 & ZKT-211012L5389-02



BT/BLE-worst mode and channel:					
Test channel	Output Power (dBm)	Tune up tolerance (dBm)	Maximum tune-up Power		Calculated value
			(dBm)	(mW)	
(BT)GFSK Highest channel	3.442	3±1	4	2.512	0.00158
(BLE)GFSK Highest channel	4.307	4±1	5	3.162	0.00199
Limit: 1.0					

EUT RF Exposure Evaluation simultaneous transmission operations

According to 865664D02 2.2 d) 1):

The sum of the ratios of the spatially averaged results to the applicable frequency dependent MPE limits :

Simultaneous transmission mode	The sum of the ratios	SUM	Limit
BT+ BLE	0.00158+0.00199	0.00357	1.0
conclusion : 0.00357<1.0, So there is no sar requirement			

2.4GWIFI:

Module A --worst mode and channel						
Test channel	Antenna Output Power (dBm)			Tune up tolerance (dBm)		
	ANT1	ANT2	SUM	ANT1	ANT2	SUM
802.11b-CH01	16.35	16.69	/	17±1	17±1	/
802.11g-CH06	14.62	15.45	/	15±1	15±1	/
802.11n20-CH11	14.14	14.15	17.16	15±1	15±1	18±1
802.11n40-CH06	12.43	12.38	15.42	13±1	13±1	16±1

Test worst case

Test channel	Maximum tune-up Power (dBm)			Maximum tune-up Power (mW)			Calculated value (mW/cm2)	Limit (mW/cm2)
	ANT1	ANT2	SUM	ANT1	ANT2	SUM	/	/
802.11b-CH01	16	16	19	39.81	39.81	79.62	0.1	1.0

Remark:

1)The Max Conducted Peak Output Power data refer to report Report No.: ZKT-211012L5389-03

2) $P_d = (P_{out} * G) / (4 * \pi * R^2) = (79.62 * 6.324) / (4 * 3.1415 * 20 * 20) = 0.1$, $G = 10^{gain/10} = 6.324$

Module B --worst mode and channel						
Test channel	Antenna Output Power (dBm)			Tune up tolerance (dBm)		
	ANT1	ANT2	SUM	ANT1	ANT2	SUM
802.11b-CH06	17.98	17.50	/	18±1	18±1	/
802.11g-CH01	15.31	15.34	/	16±1	16±1	/
802.11n20-CH01	15.21	15.20	18.22	16±1	16±1	19±1
802.11n40-CH09	14.42	14.72	17.58	15±1	15±1	18±1

Test worst case

Test channel	Maximum tune-up Power (dBm)			Maximum tune-up Power (mW)			Calculated value (mW/cm2)	Limit (mW/cm2)
	ANT1	ANT2	SUM	ANT1	ANT2	SUM	/	/
802.11b-CH01	17	17	20	50.119	50.119	100.24	0.126	1.0

Remark:

1)The Max Conducted Peak Output Power data refer to report Report No.: ZKT-211012L5389-03

2) $P_d = (P_{out} * G) / (4 * \pi * R^2) = (100.24 * 6.324) / (4 * 3.1415 * 20^2) = 0.126$, $G = 10^{gain/10} = 6.324$

5GWIFI:

Mode	Test channel	Antenna Output Power (dBm)			Tune up tolerance (dBm)			Max Tune up (dBm)
		ANT1	ANT2	SUM	ANT1	ANT2	SUM	
802.11a	36	4.82	3.89	/	4±1	4±1	/	5
	40	4.59	3.24	/	4±1	4±1	/	5
	48	2.97	2.81	/	3±1	3±1	/	4
	149	1.63	2.32	/	2±1	2±1	/	3
	157	1.45	2.81	/	2±1	2±1	/	3
	165	1.93	1.76	/	2±1	2±1	/	3
802.11n 20	36	4.12	3.07	6.64	4±1	4±1	7±1	8
	40	3.29	3.34	6.33	4±1	4±1	7±1	8
	48	1.51	2.43	5.00	2±1	2±1	5±1	6
	149	1.48	1.92	4.72	2±1	2±1	5±1	6
	157	1.50	1.67	4.60	2±1	2±1	5±1	6
	165	1.21	0.73	3.99	1±1	1±1	4±1	5
802.11n 40	38	0.43	0.84	3.65	0±1	0±1	3±1	4
	46	-0.28	-0.16	2.79	0±1	0±1	3±1	4
	151	-0.56	-0.12	2.68	0±1	0±1	3±1	4
	159	-0.30	-0.15	2.79	0±1	0±1	3±1	4

802.11ac 20	36	2.71	1.69	5.24	2±1	2±1	5±1	6
	40	2.46	2.28	5.38	2±1	2±1	5±1	6
	48	1.07	0.56	3.83	1±1	1±1	4±1	5
	149	2.78	1.24	5.09	2±1	2±1	5±1	6
	157	0.32	0.46	3.40	1±1	1±1	4±1	5
	165	-0.29	-0.03	2.85	0±1	0±1	3±1	4
802.11ac 40	38	1.24	-0.01	3.67	1±1	1±1	4±1	5
	46	-0.48	-0.93	2.31	0±1	0±1	3±1	4
	151	-0.96	-1.48	1.80	-1±1	-1±1	2±1	3
	159	-1.51	-1.38	1.57	-1±1	-1±1	2±1	3
802.11ac 80	42	-2.39	-1.67	1.00	-2±1	-2±1	1±1	2
	155	-2.31	-3.94	-0.04	-3±1	-3±1	0±1	1

Test worst case

Maximum tune-up Power (dbm)	Maximum tune-up Power (mW)	Calculated value (mW/cm ²)	Limit (mW/cm ²)
8	6.310	0.0079	1.0

Remark:

1) The Max Conducted Peak Output Power data refer to report Report No.: ZKT-211012L5389-04

2) $P_d = (P_{out} * G) / (4 * \pi * R^2) = (79.62 * 6.324) / (4 * 3.1415 * 20 * 20) = 0.0079$, $G = 10^{gain/10} = 6.324$

EUT RF Exposure Evaluation simultaneous transmission operations

According to 865664D02 2.2 d) 1):

The sum of the ratios of the spatially averaged results to the applicable frequency dependent MPE limits :

Simultaneous transmission mode	The sum of the ratios	SUM	Limit
2.4G WIFI + 5G WIFI	0.126+0.0079	0.1339	1.0
conclusion : 0.1339<1.0, So there is no sar requirement			

Combine Bluetooth +2.4G WIFI + 5G WIFI:

Simultaneous transmission mode	The sum of the ratios	SUM	Limit
2.4GWIFI + 5G WIFI+ BT+BLE	0.00357+0.1339	0.13747	1.0
conclusion 0.13747<1.0, So there is no sar requirement			

NOTE:1. EUT BT module & wifi-2.4G/5G module is more than 20cm away from the human body.

2. The sum of the ratios(2.4GWIFI + 5G WIFI+ BT+BLE) is less than the limit value of 1.0, so there is no sar requirement.