

RF EXPOSURE EVALUATION

According to FCC 1.1310: 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 §1.1307(b)

FCC ID: 2AP2R-ZALPHA3-TS

EUT Specification

EUT	Zalpha Series - Autonomous Mobile Robot
Frequency band (Operating)	☒ WLAN: 2.412GHz ~ 2.462GHz ☐ WLAN: 5.18GHz ~ 5.32GHz / 5.50GHz ~ 5.70GHz ☐ WLAN: 5.745GHz ~ 5825GHz
Device category	☐ Portable (<20cm separation) ☒ Mobile (>20cm separation)
Exposure classification	☐ Occupational/Controlled exposure (S = 5mW/cm ²) ☒ General Population/Uncontrolled exposure (S=1mW/cm ²)
Antenna diversity	☐ Single antenna ☒ Multiple antennas ☐ Tx diversity ☐ Rx diversity ☐ Tx/Rx diversity
Max. output power	20.89dBm for 802.11b; 19.07dBm for 802.11g; 21.219dBm for 802.11n(HT20); 21.925 dBm for 802.11n(HT40);
Antenna gain (Max)	2dBi (for per antenna port Max) 5dBi for MIMO(Ant1+Ant2 Directional Gain)
Evaluation applied	☒ MPE Evaluation ☐ SAR Evaluation

Limits for Maximum Permissible Exposure(MPE)

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density(mW/cm ²)	Average Time
(A) Limits for Occupational/Control Exposures				
300-1500	--	--	F/300	6
1500-100000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300-1500	--	--	F/1500	6
1500-100000	--	--	1	30

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

Where

P_d = Power density in mW/cm^2 , P_{out} =output power to antenna in Mw

G = gain of antenna in linear scale, $P_i=3.1416$

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

P_d the limit of MPE, $1mW/cm^2$. If we know the maximum gain of the antenna and total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

Measurement Result

Operation Mode	Channel Number	Channel Frequency (MHz)	Measurement Level (dBm)			Limit (dBm)	Verdict
			Ant1	Ant2	Sum		
802.11b	1	2412	20.89	20.46	--	30	PASS
	6	2437	18.79	18.20	--	30	PASS
	11	2462	18.84	18.52	--	30	PASS
802.11g	1	2412	17.61	17.24	--	30	PASS
	6	2437	16.81	18.96	--	30	PASS
	11	2462	16.83	19.07	--	30	PASS
802.11n (HT20)	1	2412	16.59	15.96	19.297	30	PASS
	6	2437	17.07	19.11	21.219	30	PASS
	11	2462	16.76	18.34	20.632	30	PASS
802.11n (HT40)	3	2422	17.22	16.92	20.083	30	PASS
	6	2437	17.32	20.07	21.919	30	PASS
	9	2452	17.22	20.13	21.925	30	PASS

Antenna 1

Operating Mode	Test Channel	Tune up tolerance (dBm)	Max tune up conducted power (dBm)	Output Peak power (mW)	Ant. Gain (dBi)	Ant. Gain (numeric)	Power density at 20cm (mW/ cm ²)	Power density Limits (mW/ cm ²)
802.11b	1	21 ± 1	22	31.6228	4	2.512	0.015803	1
	6	19 ± 1	20	31.6228	4	2.512	0.015803	1
	11	19 ± 1	20	25.1189	4	2.512	0.012552	1
802.11g	1	18 ± 1	19	25.1189	4	2.512	0.012552	1
	6	17 ± 1	18	31.6228	4	2.512	0.015803	1
	11	17 ± 1	18	25.1189	4	2.512	0.012552	1
802.11n	1	17 ± 1	18	63.096	2	1.585	0.019894	1
(HT20)	6	17 ± 1	18	63.096	2	1.585	0.019894	1
	11	17 ± 1	18	63.096	2	1.585	0.019894	1
802.11n	3	17 ± 1	18	63.096	2	1.585	0.019894	1
(HT40)	6	17 ± 1	18	63.096	2	1.585	0.019894	1
	9	17 ± 1	18	63.096	2	1.585	0.019894	1

Antenna 2:

Operating Mode	Test Channel	Tune up tolerance (dBm)	Max tune up conducted power (dBm)	Output Peak power (mW)	Ant. Gain (dBi)	Ant. Gain (numeric)	Power density at 20cm (mW/ cm ²)	Power density Limits (mW/ cm ²)
802.11b	1	20 ± 1	21	125.893	2	1.585	0.039694	1
	6	18 ± 1	19	79.433	2	1.585	0.025045	1
	11	18 ± 1	19	79.433	2	1.585	0.025045	1
802.11g	1	17 ± 1	18	63.096	2	1.585	0.019894	1
	6	19 ± 1	20	100.000	2	1.585	0.031530	1
	11	19 ± 1	20	100.000	2	1.585	0.031530	1
802.11n	1	16 ± 1	17	50.119	2	1.585	0.015803	1
(HT20)	6	19 ± 1	20	100.000	2	1.585	0.031530	1
	11	18 ± 1	19	79.433	2	1.585	0.025045	1
802.11n	3	17 ± 1	18	63.096	2	1.585	0.019894	1
(HT40)	6	20 ± 1	21	125.893	2	1.585	0.039694	1
	9	20 ± 1	21	125.893	2	1.585	0.039694	1

MPE Result:

Operation Mode	Channel Number	Channel Frequency (MHz)	Power density at 20cm (mW/ cm ²)			Power density Limits (mW/cm ²)
			Ant1	Ant2	Sum	
802.11b	1	2412	0.049972	0.039694	--	1
	6	2437	0.031530	0.025045	--	1
	11	2462	0.031530	0.025045	--	1
802.11g	1	2412	0.025045	0.019894	--	1
	6	2437	0.019894	0.031530	--	1
	11	2462	0.019894	0.031530	--	1
802.11n	1	2412	0.019894	0.015803	0.035697	1
(HT20)	6	2437	0.019894	0.015803	0.035697	1
	11	2462	0.009971	0.012552	0.022523	1
802.11n	3	2422	0.009971	0.012552	0.022523	1
(HT40)	6	2437	0.012552	0.015803	0.028355	1
	9	2452	0.009971	0.012552	0.022523	1

Signature:



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