MPE Report

Product	AC1200 MU-MIMO Dual-Band Wireless Gigabit Router
Model	NBG6615
Brand	ZYXEL
Applicant	**Zyxel Communications Corporation** No.2 Industry East RD.IX, Hsinchu Science Park, Hsinchu 30075, Taiwan, R.O.C
Manufacturer	**Zyxel Communications Corporation** No.2 Industry East RD.IX, Hsinchu Science Park, Hsinchu 30075, Taiwan, R.O.C

Exposure category: General population/uncontrolled environment
EUT Type: Production Unit
Device Type: Mobile Device
Refer Standard: KDB 447498 D01 General RF Exposure Guidance v06
FCC Part 2 §2.1091

1. Evaluation method

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

2. Limits for General Population/Uncontrolled Exposure

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$,$\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

3. Calculation Method

Predication 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

From the EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the maximum gain of the used 2.96dBi for 2.4GWLAN and 2.91dBi for 5.8GWLAN, the RF power density can be obtained.

Frequency Band	Antenna type and antenna number	Internal Identification	Maximum antenna gain
2.4GHz	WLAN Antenna	Antenna 0	2.96dBi
		Antenna 1	2.79dBi
5.8GHz	WLAN Antenna	Antenna 2	2.91dBi
		Antenna 3	2.91dBi

4. Estimation Result

4.1 Conducted Power Results

2.4GHz WIFI

Antenna	Mode	Frequency(MHz)	Conducted Output Power (dBm)
Antenna 0	IEEE 802.11b	2412	18.46
		2437	25.43
		2462	18.38
	IEEE 802.11g	2412	16.38
		2437	25.89
		2462	16.02
	IEEE 802.11n HT20	2412	19.23
		2437	25.58
		2462	18.87
	IEEE 802.11n HT40	2422	18.82
		2437	25.52
		2452	18.34

Antenna	Mode	Frequency(MHz)	Conducted Output Power (dBm)
Antenna 1	IEEE 802.11b	2412	18.31
		2437	25.23
		2462	18.19
	IEEE 802.11g	2412	16.23
		2437	25.53
		2462	16.39
	IEEE 802.11n HT20	2412	18.89
		2437	25.86
		2462	18.45
	IEEE 802.11n HT40	2422	18.23

		2437	25.56
		2452	18.45

5GHz WIFI

Antenna	Mode	Frequency(MHz)	Conducted Output Power (dBm)
Antenna 2	IEEE 802.11a	5180	21.46
		5200	22.82
		5240	22.46
		5745	22.27
		5785	22.62
		5825	22.13
	IEEE 802.11n HT20	5180	20.05
		5200	22.31
		5240	22.59
		5745	22.18
		5785	22.43
		5825	20.95
	IEEE 802.11n HT40	5190	19.33
		5230	22.07
		5755	24.54
		5795	24.53
	IEEE 802.11ac 80	5210	12.57
		5775	18.12

Antenna	Mode	Frequency(MHz)	Conducted Output Power (dBm)
Antenna 3	IEEE 802.11a	5180	22.56
		5200	24.89
		5240	24.19
		5745	23.63
		5785	24.37
		5825	22.65
	IEEE 802.11n HT20	5180	22.56
		5200	24.56
		5240	24.81
		5745	22.51
		5785	22.28
		5825	21.15
	IEEE 802.11n HT40	5190	20.61
		5230	24.13
		5755	24.49

		5795	25.14
	IEEE 802.11ac 80	5210	14.36
		5775	17.26

4.2 Manufacturing tolerance

2.4GHz WIFI

IEEE 802.11 b						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Maximum Output Power (dBm)	18.46	25.43	18.38	18.31	25.23	18.19

IEEE 802.11 g						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Maximum Output Power (dBm)	16.38	25.89	16.02	16.23	25.53	16.39

IEEE 802.11 n HT20						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Maximum Output Power (dBm)	19.23	25.58	18.87	18.89	25.86	18.45

IEEE 802.11n HT 40						
Frequency (MHz)	Antenna 0			Antenna 1		
	2422	2437	2452	2422	2437	2452
Maximum Output Power (dBm)	18.82	25.52	18.34	18.23	25.56	18.45

5GHz WIFI

IEEE 802.11 a						
Frequency (MHz)	Antenna 2			Antenna 3		
	5180	5200	5240	5180	5200	5240
Maximum Output Power (dBm)	21.46	22.82	22.46	22.56	24.89	24.19
Frequency (MHz)	Antenna 2			Antenna 3		
	5745	5785	5825	5745	5785	5825
Maximum Output Power (dBm)	22.27	22.62	22.13	23.63	24.37	22.65

IEEE 802.11n HT20						
Frequency (MHz)	Antenna 2			Antenna 3		
	5180	5200	5240	5180	5200	5240
Maximum Output Power (dBm)	20.05	22.31	22.59	22.56	24.56	24.81
Frequency (MHz)	Antenna 2			Antenna 3		
	5745	5785	5825	5745	5785	5825
Maximum Output Power (dBm)	22.18	22.43	20.95	22.51	22.28	21.15

IEEE 802.11n HT40						
Frequency (MHz)	Antenna 2			Antenna 3		
	5190	---	5230	5190	---	5230
Maximum Output Power (dBm)	19.33	---	22.07	20.61	---	24.13
Frequency (MHz)	Antenna 2			Antenna 3		
	5755	---	5795	5755	---	5795
Maximum Output Power (dBm)	24.54	---	24.53	24.49	---	25.14

IEEE 802.11ac 80						
Frequency (MHz)	Antenna 2			Antenna 3		
	5210	---	5775	5210	---	5775
Maximum Output Power (dBm)	12.57	---	18.12	14.36	---	17.26

4.3 Measurement Results

4.3.1 Standalone MPE

2.4GWLAN

Antenna 0

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	(dBm)	(mW)					
IEEE 802.11 b	25.43	349.1403	2.96	1.9770	100%	0.1374	1.0000
IEEE 802.11 g	25.89	388.1504	2.96	1.9770	100%	0.1527	1.0000
IEEE 802.11 n HT20	25.58	361.4099	2.96	1.9770	100%	0.1422	1.0000
IEEE 802.11 n HT40	25.52	356.4511	2.96	1.9770	100%	0.1403	1.0000

Antenna 1

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	(dBm)	(mW)					
IEEE 802.11 b	25.23	333.4264	2.79	1.9011	100%	0.1262	1.0000
IEEE 802.11 g	25.53	357.2728	2.79	1.9011	100%	0.1352	1.0000
IEEE 802.11 n HT20	25.86	385.4784	2.79	1.9011	100%	0.1459	1.0000
IEEE 802.11 n HT40	25.56	359.7493	2.79	1.9011	100%	0.1361	1.0000

5GWLAN

Antenna 2

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	(dBm)	(mW)					
IEEE 802.11 a	22.82	333.4264	2.91	1.9543	100%	0.1262	1.0000
IEEE 802.11 n HT20	22.59	357.2728	2.91	1.9543	100%	0.1352	1.0000
IEEE 802.11 n HT40	24.54	385.4784	2.91	1.9543	100%	0.1459	1.0000
IEEE 802.11 ac 80	18.12	359.7493	2.91	1.9543	100%	0.1361	1.0000

Antenna 3

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	(dBm)	(mW)					
IEEE 802.11 a	24.89	191.4256	2.91	1.9543	100%	0.0745	1.0000
IEEE 802.11 n HT20	24.81	181.5516	2.91	1.9543	100%	0.0706	1.0000
IEEE 802.11 n HT40	25.14	284.4461	2.91	1.9543	100%	0.1106	1.0000
IEEE 802.11 ac 80	17.26	64.8634	2.91	1.9543	100%	0.0252	1.0000

Remark:

1. *Maximum average power including tune-up tolerance;*
2. *MPE use distance is 20cm from manufacturer declaration of user manual.*

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

∑ of MPE ratios ≤ 1.0

Antenna 0 and Antenna 1 and Antenna 2 for 2.4GWLAN and 5GWLAN

Band	Mode	MPE Ratio Antenna 0	MPE Ratio Antenna 1	∑ MPE ratios	Limit	Results
2.4G	IEEE 802.11b	0.1374	0.1262	0.3	1.000	Pass
	IEEE 802.11g	0.1527	0.1352	0.3	1.000	Pass
	IEEE 802.11n HT20	0.1422	0.1459	0.3	1.000	Pass
	IEEE 802.11n HT40	0.1403	0.1361	0.3	1.000	Pass

Band	Mode	MPE Ratio Antenna 2	MPE Ratio Antenna 3	∑ MPE ratios	Limit	Results
5G	IEEE 802.11a	0.1262	0.0745	0.2	1.000	Pass
	IEEE 802.11n HT20	0.1352	0.0706	0.2	1.000	Pass
	IEEE 802.11n HT40	0.1459	0.1106	0.3	1.000	Pass
	IEEE 802.11ac 80	0.1361	0.0252	0.1	1.000	Pass

Maximum MPE Ratios for 2.4GHz and 5GHz WLAN simultaneous transmission

Maximum MPE $Ratio_{2.4GHzWLAN}$	Maximum MPE $Ratio_{5GHzWLAN}$	∑MPEratios	Limit	Results
0.2881	0.2565	0.5446	1.000	Pass

Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

---------- END OF REPORT----------