

FCC RF Exposure Evaluation

1. Product Information

FCC ID	2AWDN-PJ90
Product Name	Laser Projector
Test Model	PJ90
Power Supply	Input: 100-240V~, 50/60Hz, 2.5A
Modulation Type	Bluetooth: GFSK Bluetooth LE: GFSK 2.4G WIFI: 802.11b: DSSS 802.11g/802.11n(H20)/802.11n(H40): OFDM 5G WIFI : IEEE 802.11a/ac/n: OFDM
Antenna Type	PIFA Antenna
Antenna Gain	Bluetooth: 3.48dBi 2.4G WIFI: 2.86dBi 5G WIFI : 3.48dBi
Frequency Range	2402 – 2480MHz / 2412 – 2462MHz / 5180 – 5240MHz 5745 – 5825MHz/ 5260 – 5320MHz / 5500 – 5700MHz
Exposure Category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

2. Evaluation Method and Limit

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 modelled 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.

3. Limit

3.1 Refer Evaluation Method

[ANSI C95.1-1999](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[FCC KDB publication 447498 D01 General RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1091](#): Radiofrequency radiation exposure evaluation: mobile devices

3.2 Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
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

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 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

*=Plane-wave equivalent power density

4. MPE 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

5. Antenna Information

PJ90 can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Note
PIFA Antenna	2402 MHz – 2480 MHz 2412 MHz – 2462 MHz 5180MHz - 5240MHz 5260MHz-5320MHz 5500MHz-5700MHz 5745MHz -5825MHz	Bluetooth: 3.48dBi 2.4G WIFI: 2.86dBi 5G WIFI : 3.48dBi	Bluetooth & WLAN Antenna

6. Conducted Power Results**[BT]**

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	3.97
	39	2441	4.73
	78	2480	4.49
$\pi/4$ DQPSK	0	2402	4.03
	39	2441	4.80
	78	2480	4.58
8DPSK	0	2402	4.43
	39	2441	5.21
	78	2480	4.98

[BLE]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	2.90
	19	2440	3.65
	39	2480	3.40

[2.4GWIFI Max Conducted Power]

Mode	Channel	Frequency(MHz)	Max Conducted Power(dBm)
IEEE 802.11b	1	2412	13.35
	6	2437	14.03
	11	2462	13.53
IEEE 802.11g	1	2412	10.91
	6	2437	11.68
	11	2462	11.39
IEEE 802.11n HT20	1	2412	10.29
	6	2437	11.10
	11	2462	10.83
IEEE 802.11n HT40	3	2422	10.94
	6	2437	11.54
	9	2452	11.13

[5.2GWIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)
11A	36	5180	2.34
	40	5200	3.16
	48	5240	4.46
11N20 SISO	36	5180	1.83
	40	5200	2.00
	48	5240	3.07
11N40 SISO	38	5190	2.72
	46	5230	3.71
11AC20 SISO	36	5180	1.86
	40	5200	1.91
	48	5240	3.11
11AC40 SISO	38	5190	1.94
	46	5230	4.03
11AC80 SISO	42	5210	2.93

[5.8WIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)
11A	149	5745	4.89
	157	5785	4.39
	165	5825	3.66
11N20 SISO	149	5745	3.89
	157	5785	3.15
	165	5825	2.43
11N40 SISO	151	5755	3.77
	159	5795	2.71
11AC20 SISO	149	5745	3.97
	157	5785	3.28
	165	5825	2.48
11AC40 SISO	151	5755	3.76
	159	5795	2.82
11AC80 SISO	155	5775	3.45

[5.3GWIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)
11A	52	5260	3.46
	60	5300	2.84
	64	5320	3.28
11N20 SISO	52	5260	2.13
	60	5300	1.71
	64	5320	2.18
11N40 SISO	54	5270	2.47
	62	5310	2.19
11AC20 SISO	52	5260	2.29
	60	5300	1.92
	64	5320	2.27
11AC40 SISO	54	5270	2.40
	62	5310	2.15
11AC80 SISO	58	5290	2.47

[5.5WIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)
11A	100	5500	3.47
	116	5580	3.67
	140	5700	5.49
11N20 SISO	100	5500	2.12
	116	5580	2.51
	140	5700	4.41
11N40 SISO	102	5510	2.93
	118	5550	2.89
	134	5670	4.90
11AC20 SISO	100	5500	2.29
	116	5580	2.60
	140	5700	4.67
11AC40 SISO	102	5510	2.94
	118	5550	2.86
	134	5670	4.84
11AC80 SISO	106	5530	2.89
	122	5610	4.01

7.Manufacturing Tolerance**<BT >**

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	4.0	4.0	4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
π /4DQPSK(Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	4.0	4.0	4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
8DPSK(Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	4.0	5.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

<BLE>

GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	3.0	3.0	3.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

<2.4GWLAN >

IEEE 802.11b (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.0	14.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11g (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	11.0	11.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	11.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n H420 (Peak)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	11.0	11.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

<5.2GWLAN >

11A (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	2.0	3.0	4.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	2.0	2.0	3.0
Tolerance ±(dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	Channel 38		Channel 46
Target (dBm)	3.0		4.0
Tolerance ±(dB)	1.0		1.0
11AC20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	2.0	2.0	3.0
Tolerance ±(dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	Channel 38		Channel 46
Target (dBm)	2.0		4.0
Tolerance ±(dB)	1.0		1.0
11AC80 (Average)			
Channel	Channel 42		/
Target (dBm)	3.0		/
Tolerance ±(dB)	1.0		/

<5.8GWLAN>

11A (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	5.0	4.0	4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20 SISO (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	4.0	3.0	2.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	Channel 151		Channel 159
Target (dBm)	4.0		3.0
Tolerance $\pm$ (dB)	1.0		1.0
11AC20 SISO (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	4.0	3.0	0.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	Channel 151		Channel 159

Target (dBm)	2.0	3.0
Tolerance $\pm$ (dB)	1.0	1.0
11AC80 (Average)		
Channel	Channel 155	/
Target (dBm)	4.0	/
Tolerance $\pm$ (dB)	1.0	/

<5.3GWLAN >

11A (Average)			
Channel	Channel 52	Channel 60	Channel 64
Target (dBm)	3.0	3.0	3.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20 (Average)			
Channel	Channel 52	Channel 60	Channel 64
Target (dBm)	2.0	2.0	2.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	Channel 54	Channel 62	
Target (dBm)	2.0	2.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC20 (Average)			
Channel	Channel 52	Channel 60	Channel 64
Target (dBm)	2.0	2.0	2.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	Channel 54	Channel 62	
Target (dBm)	2.0	2.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC80 (Average)			
Channel	Channel 58	/	
Target (dBm)	2.0	/	
Tolerance $\pm$ (dB)	1.0	/	

<5.5GWLAN>

11A (Average)			
Channel	Channel 100	Channel 116	Channel 140
Target (dBm)	3.0	4.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20 SISO (Average)			
Channel	Channel 100	Channel 116	Channel 140
Target (dBm)	2.0	2.0	4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	Channel 102	Channel 118	Channel 134
Target (dBm)	3.0	3.0	5.0

Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC20 SISO (Average)			
Channel	Channel 100	Channel 116	Channel 140
Target (dBm)	2.0	3.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	Channel 102	Channel 118	Channel 134
Target (dBm)	3.0	3.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC80 (Average)			
Channel	Channel 106	Channel 122	
Target (dBm)	3.0	4.0	
Tolerance $\pm$ (dB)	1.0	1.0	

8. Evaluation Results

8.1 Standalone MPE

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r=20\text{cm}$, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

BT

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW					
GFSK	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
$\pi/4$ DQPSK	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
8-DPSK	6.0	3.9811	3.48	2.2284	100%	0.0018	1.0000

BLE

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW					
GFSK	4.0	2.5119	3.48	2.2284	100%	0.0011	1.0000

2.4G

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW					
IEEE 802.11b	15.0	31.6228	2.86	1.9320	100%	0.0122	1.0000
IEEE 802.11g	12.0	15.8489	2.86	1.9320	100%	0.0061	1.0000
IEEE 802.11n HT20	12.0	15.8489	2.86	1.9320	100%	0.0061	1.0000
IEEE 802.11n HT40	12.0	15.8489	2.86	1.9320	100%	0.0061	1.0000

5.2G

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
IEEE 802.11 n HT20	4.0	2.5119	3.48	2.2284	100%	0.0011	1.0000
IEEE 802.11 n HT40	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
IEEE 802.11 ac20	4.0	2.5119	3.48	2.2284	100%	0.0011	1.0000
IEEE 802.11 ac40	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
IEEE 802.11 ac80	4.0	2.5119	3.48	2.2284	100%	0.0011	1.0000

5.8G

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	6.0	3.9811	3.48	2.2284	100%	0.0018	1.0000
IEEE 802.11 n HT20	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
IEEE 802.11 n HT40	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
IEEE 802.11 ac20	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
IEEE 802.11 ac40	4.0	2.5119	3.48	2.2284	100%	0.0011	1.0000
IEEE 802.11 ac80	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000

5.3G

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	4.0	2.5119	3.48	2.2284	100%	0.0011	1.0000
IEEE 802.11 n HT20	3.0	1.9953	3.48	2.2284	100%	0.0009	1.0000
IEEE 802.11 n HT40	3.0	1.9953	3.48	2.2284	100%	0.0009	1.0000
IEEE 802.11 ac20	3.0	1.9953	3.48	2.2284	100%	0.0009	1.0000
IEEE 802.11 ac40	3.0	1.9953	3.48	2.2284	100%	0.0009	1.0000
IEEE 802.11 ac80	3.0	1.9953	3.48	2.2284	100%	0.0009	1.0000

5.5G

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	6.0	3.9811	3.48	2.2284	100%	0.0018	1.0000
IEEE 802.11 n HT20	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000
IEEE 802.11 n HT40	6.0	3.9811	3.48	2.2284	100%	0.0018	1.0000
IEEE 802.11 ac20	6.0	3.9811	3.48	2.2284	100%	0.0018	1.0000
IEEE 802.11 ac40	6.0	3.9811	3.48	2.2284	100%	0.0018	1.0000
IEEE 802.11 ac80	5.0	3.1623	3.48	2.2284	100%	0.0014	1.0000

Remark:

1. Output power including tune-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer;

8.2 Simultaneous Transmission MPE

The sample supports a modular, 2 antennas, Bluetooth/2.4G WLAN/5G WLAN can be activated at the same time, but can only switch package interleaving and antenna at the board level. This means they don't transmit at the same time, and MIMO mode is not supported. No need to consider simultaneous transmission;

9. Conclusion

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

.....THE END OF REPORT.....