

Maximum Permissible Exposure Report

1. Product Information

FCC ID	: 2AXXL-020AC9
EUT	: Kraydel Hub
Test Model	: Konnect
Power Supply	: For adapter Input: 100-240V AC, 50/60Hz, 0.9-0.45A For adapter Output: 12V=3A, 36W MAX.
Hardware Version	: V1
Software Version	: 201
Bluetooth	
Frequency Range	: 2402MHz ~ 2480MHz
Bluetooth Version	: V4.0
Bluetooth Channel Number	: 79 channels for Bluetooth V4.0 (BDR/EDR) 40 channels for Bluetooth V4.0 (BT LE)
Bluetooth Channel Spacing	: 1MHz for Bluetooth V4.0 (BDR/EDR) 2MHz for Bluetooth V4.0 (BT LE)
Bluetooth Modulation Type	: GFSK, $\pi/4$ -DQPSK, 8-DPSK for Bluetooth V4.0 (BDR/EDR) GFSK for Bluetooth V4.0 (BT LE)

WIFI(2.4G Band)

Frequency Range	: 2412MHz ~ 2462MHz
Channel Number	: 11 Channels for 20MHz bandwidth (2412MHz ~ 2462MHz) 7 Channels for 40MHz bandwidth (2422MHz ~ 2452MHz)
Channel Spacing	: 5MHz
Modulation Type	: IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n: OFDM (64QAM, 16QAM, QPSK, BPSK)

WIFI(5.2G Band)

Frequency Range	: 5180MHz ~ 5240MHz
Channel Number	: 4 channels for 20MHz bandwidth(5180MHz ~ 5240MHz) 2 channels for 40MHz bandwidth(5190MHz ~ 5230MHz) 1 channels for 80MHz bandwidth(5210MHz)
Modulation Type	: 802.11A/N/AC: OFDM (64QAM, 16QAM, QPSK, BPSK)

WIFI(5.8G Band)

Frequency Range	: 5745MHz ~ 5825MHz
Channel Number	: 5 channels for 20MHz bandwidth(5745MHz ~ 5825MHz) 2 channels for 40MHz bandwidth(5755MHz ~ 5795MHz) 1 channels for 80MHz bandwidth(5775MHz)
Modulation Type	: 802.11A/N/AC: OFDM (64QAM, 16QAM, QPSK, BPSK)
Antenna Description	: PCB Antenna(ANT 0), 2.0dBi(Max.), used for Bluetooth & WIFI PCB Antenna(ANT 1), 2.0dBi(Max.), used for WIFI
Exposure category	: General population/uncontrolled environment
EUT Type	: Production Unit
Device Type	: Mobile Device

2. 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 KDB447498 D01 General RF Exposure Guidance v06 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

Netbox Duo can only use antennas certificated as follows provided by manufacturer;

Internal Identification	Antenna Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain
Ant_0	Bluetooth & WIFI	PCB Antenna	2400MHz – 2500MHz 5150MHz -5850MHz	2.0dBi(Max.)
Ant_1	Wifi	PCB Antenna	2400MHz – 2500MHz 5150MHz -5850MHz	2.0dBi(Max.)

6. Conducted Power

[BT Max Conducted Power]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	-1.068
	39	2441	-0.809
	78	2480	-1.148
$\pi/4$ DQPSK	0	2402	1.222
	39	2441	1.452
	78	2480	1.096
8DPSK	0	2402	1.452
	19	2440	1.713
	39	2480	1.318

[BT LE Max Conducted Power]

Mode	Channel	Frequency (MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	3.074
	19	2440	3.268
	39	2480	2.837

[2.4GWIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)	Max Conducted Power(dBm)
			ANT 0	ANT 1
IEEE 802.11b	1	2412	16.81	16.63
	6	2437	17.59	17.47
	11	2462	17.86	17.77
IEEE 802.11g	1	2412	16.03	15.94
	6	2437	16.96	16.91
	11	2462	17.25	17.22
IEEE 802.11n HT20	1	2412	15.21	15.18
	6	2437	16.62	16.59
	11	2462	16.90	16.87
IEEE 802.11n HT40	3	2422	15.77	15.79
	6	2437	16.31	16.25
	9	2452	16.55	16.48

[5.2GWIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)	Max Conducted Power(dBm)
			ANT 0	ANT 1
11A	36	5180	16.00	16.11
	40	5200	16.67	16.64
	48	5240	17.25	17.18
11N20 SISO	36	5180	15.23	15.01
	40	5200	16.01	15.61
	48	5240	16.59	16.63
11N40 SISO	38	5190	15.14	14.69
	46	5230	16.29	15.93
11AC20 SISO	36	5180	15.49	14.95
	40	5200	16.10	15.60
	48	5240	16.51	16.54
11AC40 SISO	38	5190	15.27	14.76
	46	5230	16.24	15.81
11AC80 SISO	42	5210	15.86	15.29

[5.8GWIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)	Max Conducted Power(dBm)
			ANT 0	ANT 1
11A	149	5745	17.36	17.29
	157	5785	17.89	17.76
	165	5825	18.57	18.36
11N20 SISO	149	5745	16.48	16.07
	157	5785	17.02	16.54
	165	5825	18.18	17.82
11N40 SISO	151	5755	16.25	15.70
	159	5795	17.32	16.75
11AC20 SISO	149	5745	15.09	14.95
	157	5785	15.60	15.60
	165	5825	16.69	16.54
11AC40 SISO	151	5755	15.27	14.76
	159	5795	16.44	15.81
11AC80 SISO	155	5775	16.85	15.99

7. Manufacturing tolerance

BT			
GFSK			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	-1	-1	-1
Tolerance $\pm$ (dB)	1	1	1
$\pi/4$ DQPSK			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1	1	1
Tolerance $\pm$ (dB)	1	1	1
8DPSK			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	1	1	1
Tolerance $\pm$ (dB)	1	1	1

BLE			
BT LE (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	3	3	3
Tolerance $\pm$ (dB)	1	1	1

2.4GWIFI (ANT 0)

IEEE 802.11b			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	17	17	17
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11g			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16	17	17
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n20			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16	16	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n40			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	16	16	16
Tolerance $\pm$ (dB)	1	1	1

2.4GWIFI (ANT 1)

IEEE 802.11b			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	17	17	17
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11g			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16	17	17
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n20			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	16	16	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n40			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	16	16	16
Tolerance $\pm$ (dB)	1	1	1

5.2GWIFI (ANT 0)

IEEE 802.11a			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	16	16	17
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	15	16	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT20			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	15	16	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n40			
Channel	Channel 38	Channel 46	/
Target (dBm)	15	16	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT40			
Channel	Channel 38	Channel 46	/
Target (dBm)	15	16	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT80			
Channel	Channel 42	/	/
Target (dBm)	15	/	/
Tolerance $\pm$ (dB)	1	/	/

5.2GWIFI (ANT 1)

IEEE 802.11a			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	16	16	17
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	15	16	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT20			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	15	16	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n40			
Channel	Channel 38	Channel 46	/
Target (dBm)	15	16	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT40			
Channel	Channel 38	Channel 46	/

Target (dBm)	15	16	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT80			
Channel	Channel 42	/	/
Target (dBm)	15	/	/
Tolerance $\pm$ (dB)	1	/	/

5.8GWIFI (ANT 0)

IEEE 802.11a			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	18	18	18
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	16	17	18
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT20			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	15	15	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n40			
Channel	Channel 151	Channel 159	/
Target (dBm)	16	17	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT40			
Channel	Channel 151	Channel 159	/
Target (dBm)	15	16	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT80			
Channel	Channel 155	/	/
Target (dBm)	16	/	/
Tolerance $\pm$ (dB)	1	/	/

5.8GWIFI (ANT 1)

IEEE 802.11a			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	18	18	18
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n HT20			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	16	17	18
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11ac VHT20			

Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	15	15	16
Tolerance $\pm$ (dB)	1	1	1
IEEE 802.11n40			
Channel	Channel 151	Channel 159	/
Target (dBm)	16	17	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT40			
Channel	Channel 151	Channel 159	/
Target (dBm)	15	16	/
Tolerance $\pm$ (dB)	1	1	/
IEEE 802.11ac VHT80			
Channel	Channel 155	/	/
Target (dBm)	16	/	/
Tolerance $\pm$ (dB)	1	/	/

8. Measurement 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 Classics]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
GFSK	0	1.0000	2.0	1.5849	100%	0.0003	1.0000
$\pi/4$ -DQPSK	2	1.5849	2.0	1.5849	100%	0.0005	1.0000
8-DPSK	2	1.5849	2.0	1.5849	100%	0.0005	1.0000

[BT LE]

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	2.5119	2.0	1.5849	100%	0.0008	1.0000

[2G4WLAN ANT 0]

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	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11g	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11n HT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11n HT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000

[5GHz WLAN Band 1 ANT 0]

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	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11n HT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11n HT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT80	16	39.8107	2.0	1.5849	100%	0.0126	1.0000

[5GHz WLAN Band 3 ANT 0]

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	19	79.4328	2.0	1.5849	100%	0.0251	1.0000
IEEE 802.11n HT20	19	79.4328	2.0	1.5849	100%	0.0251	1.0000
IEEE 802.11ac VHT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11n HT40	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11ac VHT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT80	17	50.1187	2.0	1.5849	100%	0.0158	1.0000

[2G4WLAN ANT 1]

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	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11g	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11n HT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11n HT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000

[5GHz WLAN Band 1 ANT 1]

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	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11n HT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11n HT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT80	16	39.8107	2.0	1.5849	100%	0.0126	1.0000

[5GHz WLAN Band 3 ANT 1]

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	19	79.4328	2.0	1.5849	100%	0.0251	1.0000
IEEE 802.11n HT20	19	79.4328	2.0	1.5849	100%	0.0251	1.0000
IEEE 802.11ac VHT20	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11n HT40	18	63.0957	2.0	1.5849	100%	0.0199	1.0000
IEEE 802.11ac VHT40	17	50.1187	2.0	1.5849	100%	0.0158	1.0000
IEEE 802.11ac VHT80	17	50.1187	2.0	1.5849	100%	0.0158	1.0000

Remark:

1. Output power including turn-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer.
3. $MPE\ values = PG/4\pi R^2$;
4. The maximum permissible exposure for 300~1500MHz is $f/1500\ mW/cm^2$,
for 1500~100,000MHz is $1.0\ mW/cm^2$.

8.2 Simultaneous Transmission MPE

Bluetooth and WIFI can simultaneous transmit, the WIFI mode of 802.11n/ac can simultaneous transmit. According to KDB447498 D01 General RF Exposure Guidance v06 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

Σ of MPE ratios ≤ 1.0

Antenna 0	Antenna 1	Σ MPE ratios	Limit	Results
0.0251	0.0251	0.0502	1.0	PASS

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-----