

MPE Report

Applicant : Mako Networks
Product Type : 11ax 2x2 WiFi AP with LTE connectivity
Trade Name : Mako Networks
Model Number : 5600, 5600-5G
Applicable Standard : IEEE Std.C95.1
47 CFR § 2.1091 / 47 CFR § 1.1310
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Taiwan Accreditation Foundation accreditation number: 1330
Test Firm MRA designation number: TW0010

Note:

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Revision History

Rev.	Issued Date	Revisions	Revised By
00	Aug. 26, 2021	Initial Issue	Nicole Chu
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Contents

1.	Reference Applicable Standard.....	4
2.	Description of Equipment under Test (EUT).....	5
3.	Human Exposure Assessment.....	8
4.	Power Density Limit – RF Exposure Evaluation.....	9
5.	Test Result	10



1. Reference Applicable Standard

Standard	Description	Version
IEEE C95.1	American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 KHz to 100 GHz, New York.	1992
47 CFR Part §2.1091	Radiofrequency radiation exposure evaluation: mobile devices.	-
47 CFR Part §1.1310	Radiofrequency radiation exposure limits.	-



2. Description of Equipment under Test (EUT)

Applicant	Mako Networks 1355 N. McLean Blvd, Elgin, Illinois 60123, United States	
Manufacturer	Mako Networks 1355 N. McLean Blvd, Elgin, Illinois 60123, United States	
Product Type	11ax 2x2 WiFi AP with LTE connectivity	
Trade Name	Mako Networks	
Model Number	5600, 5600-5G	
FCC ID	2AVQL-5600	
Models different description	All models are electrically identical, different model names are for marketing purpose.	
Frequency Range	Operate Band	Frequency Range (MHz)
	WCDMA(RMC12.2K)/HSDPA/HSUPA Band II	1850 - 1910
	WCDMA(RMC12.2K)/HSDPA/HSUPA Band IV	1710 - 1755
	WCDMA(RMC12.2K)/HSDPA/HSUPA Band V	824 - 849
	LTE Band 2	1850 - 1910
	LTE Band 4	1710 - 1755
	LTE Band 5	824 - 849
	LTE Band 7	2500 - 2570
	LTE Band 12	699 - 716
	LTE Band 13	777 - 787
	LTE Band 14	788 - 798
	LTE Band 17	704 - 716
	LTE Band 25	1850 - 1915
	LTE Band 26	814 - 849
	LTE Band 30	2305 - 2315
	LTE Band 38	2570 - 2620
	LTE Band 41	2496 - 2690
	LTE Band 48	3550 - 3700
	LTE Band 66	1710-1780
	LTE Band 71	663 - 698
	5G NR n2	1850 - 1910
	5G NR n5	824 - 849
	5G NR n7	2500 - 2570
	5G NR n12	699 - 716
	5G NR n25	1850 - 1915
	5G NR n41	2496 - 2690
	5G NR n66	1710 - 1780
5G NR n71	663 - 698	
5G NR n77	3700 - 3980	



Frequency Range	Operate Band		Frequency Range (MHz)	
	IEEE 802.11b/g/n/ax 2.4 GHz 20 MHz		2412 - 2462	
	IEEE 802.11n/ax 2.4 GHz 40 MHz		2422 - 2452	
	IEEE 802.11a/n/ac/ax 5 GHz 20 MHz U-NII Band I		5180 - 5240	
	IEEE 802.11a/n/ac/ax 5 GHz 20 MHz U-NII Band III		5745 - 5825	
	IEEE 802.11n/ac/ax 5 GHz 40 MHz U-NII Band I		5190 - 5230	
	IEEE 802.11n/ac/ax 5 GHz 40 MHz U-NII Band III		5755 - 5795	
	IEEE 802.11ac/ax 5 GHz 80 MHz U-NII Band I		5210	
	IEEE 802.11ac/ax 5 GHz 80 MHz U-NII Band III		5775	
	Bluetooth LE		2402 - 2480	
Antenna Information	Model	Type	Max. Gain (dBi)	
	7102A0482000	Diople Antenna	WCDMA Band II	-0.40
	7102A0482000	Diople Antenna	WCDMA Band IV	-1.50
	7102A0483000	Diople Antenna	WCDMA Band V	-1.00
	7102A0482000	Diople Antenna	LTE Band 2	-0.40
	7102A0482000	Diople Antenna	LTE Band 4	-1.50
	7102A0483000	Diople Antenna	LTE Band 5	-1.00
	7102A0482000	Diople Antenna	LTE Band 7	-0.90
	7102A0483000	Diople Antenna	LTE Band 12	-0.30
	7102A0483000	Diople Antenna	LTE Band 13	-0.20
	7102A0483000	Diople Antenna	LTE Band 14	-0.20
	7102A0483000	Diople Antenna	LTE Band 17	-0.30
	7102A0482000	Diople Antenna	LTE Band 25	-0.40
	7102A0483000	Diople Antenna	LTE Band 26	-0.20
	7102A0482000	Diople Antenna	LTE Band 30	-4.40
	7102A0482000	Diople Antenna	LTE Band 38	0.70
	7102A0482000	Diople Antenna	LTE Band 41	0.70
	7102A0484000	Diople Antenna	LTE Band 48	-7.00
	7102A0482000	Diople Antenna	LTE Band 66	-1.50
	7102A0483000	Diople Antenna	LTE Band 71	-0.30



	Model	Type	Max. Gain (dBi)	
	Antenna Information	7102A0482000	Diople Antenna	5G NR n2
7102A0483000		Diople Antenna	5G NR n5	-1.00
7102A0482000		Diople Antenna	5G NR n7	-0.90
7102A0483000		Diople Antenna	5G NR n12	-0.30
7102A0482000		Diople Antenna	5G NR n25	-0.40
7102A0482000		Diople Antenna	5G NR n41	0.70
7102A0482000		Diople Antenna	5G NR n66	-1.50
7102A0483000		Diople Antenna	5G NR n71	-0.30
7102A0484000		Diople Antenna	5G NR n77	-4.20
5718A0640300		PIFA Antenna	Bluetooth	3.64
5718A0640300		PIFA Antenna	WLAN 2.4 G ANT-0	4.26
5718A0637300		PIFA Antenna	WLAN 2.4 G ANT-1	3.14
G _{ANT}			3.74	
Directional			6.73	
5718A0638300		PIFA Antenna	WLAN 5 G Band I ANT-0	3.94
5718A0638300		PIFA Antenna	WLAN 5 G Band I ANT-1	5.73
G _{ANT}			4.93	
Directional			7.89	
5718A0639300		PIFA Antenna	WLAN 5 G Band III ANT-0	3.81
5718A0639300		PIFA Antenna	WLAN 5 G Band III ANT-1	4.96
G _{ANT}			4.42	
Directional			7.41	
Antenna Delivery		IEEE 802.11b/g: 2TX / 2RX (CDD) IEEE 802.11n/ax 2.4 GHz 20 MHz / 40 MHz: 2TX / 2RX (MIMO / Beamforming on) IEEE 802.11a: 2TX / 2RX (CDD) IEEE 802.11n/ac/ax 20 MHz / 40 MHz / 80 MHz: 2TX / 2RX (MIMO / Beamforming on)		
RF Evaluation	0.546 mW/cm ²			
Operate Temp. Range	0 ~ +40°C			

Note:

1. The above equipment was tested by A Test Lab Techno Corp. For compliance with the requirements set forth in 47 CFR § 2.1091 / 47 CFR § 1.1310. The results of testing in this report apply only to the product/system, which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.
2. WWAN reference to the FCC ID MSQAX201NG.

3. *Human Exposure Assessment*

Due to the design and installation of this product, it is not possible to conduct SAR evaluation. This is because client either manufactures or supplies the antenna(s) that will be used in the installation of this product. Therefore, this product will be evaluated as a mobile device per 47 CFR § 1.1310 titled "Radiofrequency radiation exposure limits", generally referred to as MPE limits.

In 47 CFR § 2.1091, paragraph (b) defines a mobile device as "a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons." This product is intended to be installed into a vehicle such that the unit is physically secured at one location. In the installation guide supplied with the product,

Client has made the following statement: "IMPORTANT: To meet the FCC's RF Exposure Guidelines, the antenna should be installed so there is at least 20 cm of separation between the body of the user and nearby persons and the antenna". Based on the installation of the transceiver and the antenna, the transmitters radiating structure is more than 20 cm from the user. Thus, this product is a "mobile device" as defined in section § 2.1091 paragraph (b).

Exposure evaluation

$$S_{eirp} = \frac{EIRP}{4\pi d^2} = \frac{PG}{4\pi d^2} (W / m^2)$$

Where

S: is the input power (W);

G: is the antenna gain;

d : is the distance between antennas and evaluation point (m).



4. Power Density Limit – RF Exposure Evaluation

Thv In 47 CFR § 1.1310, use of the device as based upon the user's awareness and ability to exercise control over human exposure. The two categories defined are Occupational / Controlled Exposure and General Population / Uncontrolled. These two categories are defined as follow:

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 ²)*	30
30-300	27.5	0.073	0.2	30
300-1500	-	-	F / 1,500	30
1,500-100,000	-	-	1.0	30
Limits for Occupational / Controlled 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)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1,842 / f	4.89 / f	(900 / f ²)*	6
30-300	61.4	0.163	1.0	6
300-1,500	-	-	F / 300	6
1,500-100,000	-	-	5	6



5. Test Result

Antenna	Band	Frequency (MHz)	Limit (mW)/cm ²	Distance	Tune-up Power	ANT Gain	Numeric Gain	Duty Cycle	Power with Duty cycle	Power Density
				(cm)	(dBm)				(mW)	(mW)/cm ²
				[R]	[P]				[P]x[G]	[S]
WWAN Antenna	WCDMA Band II	1852.4-1907.6	1.000	20	25.00	-0.40	0.91	1	287.77	0.057
	WCDMA Band IV	1712.4-1752.6	1.000	20	25.00	-1.50	0.71	1	224.52	0.045
	WCDMA Band V	826.4-846.6	0.564	20	25.00	-1.00	0.79	1	249.82	0.050
	LTE Band 2	1850-1910	1.000	20	25.00	-0.40	0.91	1	287.77	0.057
	LTE Band 4	1710-1755	1.000	20	25.00	-1.50	0.71	1	224.52	0.045
	LTE Band 5	824-849	0.566	20	25.00	-1.00	0.79	1	249.82	0.050
	LTE Band 7	2500-2570	1.000	20	25.00	-0.90	0.81	1	256.14	0.051
	LTE Band 12	699-716	0.477	20	25.00	-0.30	0.93	1	294.09	0.059
	LTE Band 13	777-787	0.525	20	25.00	-0.20	0.95	1	300.42	0.060
	LTE Band 14	788-798	0.532	20	25.00	-0.20	0.95	1	300.42	0.060
	LTE Band 17	777-787	0.525	20	25.00	-0.30	0.93	1	294.09	0.059
	LTE Band 25	1850-1915	1.000	20	25.00	-0.40	0.91	1	287.77	0.057
	LTE Band 26	814-849	0.566	20	25.00	-0.20	0.95	1	300.42	0.060
	LTE Band 30	2305-2315	1.000	20	25.00	-4.40	0.36	1	113.84	0.023
	LTE Band 38	2570-2620	1.000	20	25.00	0.70	1.17	1	369.99	0.074
	LTE Band 41	2496-2690	1.000	20	28.00	0.70	1.17	1	738.22	0.147
	LTE Band 48	3550-3700	1.000	20	28.00	-7.00	0.20	1	126.19	0.025
	LTE Band 66	1710-1780	1.000	20	28.00	-1.50	0.71	1	447.98	0.089
	LTE Band 71	663-698	0.465	20	25.00	-0.30	0.93	1	294.09	0.059
	n2	1850-1910	1.000	20	25.00	-0.40	0.91	1	287.77	0.057
	n5	824-849	0.566	20	25.00	-1.00	0.79	1	249.82	0.050
	n7	2500-2570	1.000	20	25.00	-0.90	0.81	1	256.14	0.051
	n12	699-716	0.477	20	25.00	-0.30	0.93	1	294.09	0.059
n25	1850-1915	1.000	20	25.00	-0.40	0.91	1	287.77	0.057	
n41	2496-2690	1.000	20	28.00	0.70	1.17	1	738.22	0.147	
n66	1710-1780	1.000	20	25.00	-1.50	0.71	1	224.52	0.045	
n71	663-698	0.465	20	25.00	-0.30	0.93	1	294.09	0.059	
n77	3700-3980	1.000	20	28.00	-4.20	0.38	1	239.76	0.048	
Bluetooth Antenna	Bluetooth	2402-2480	1.000	20	7.00	3.64	2.31	1	11.58	0.002
Wi-Fi Antenna 0	2.4GHz	2412-2462	1.000	20	20.00	3.74	2.37	1	237.00	0.047
	5GHz	5150-5250	1.000	20	21.00	4.93	3.11	1	391.53	0.078
		5725-5850	1.000	20	21.00	4.42	2.77	1	348.72	0.069
Wi-Fi Antenna 1	2.4GHz	2412-2462	1.000	20	20.00	3.74	2.37	1	237.00	0.047
	5GHz	5150-5250	1.000	20	21.00	4.93	3.11	1	391.53	0.078
		5725-5850	1.000	20	21.00	4.42	2.77	1	348.72	0.069
Wi-Fi Antenna (Beamforming)	2.4GHz	2412-2462	1.000	20	19.00	6.73	4.71	1	374.13	0.074
	5GHz	5150-5250	1.000	20	20.50	7.89	6.15	1	690.04	0.137
			5725-5850	1.000	20	20.50	7.41	5.51	1	618.23



Note:

1. Mobile or fixed location transmitters, minimum separation distance is 20 cm, even if calculations indicate MPE distance is less.
2. We used the maximum power and gain to provide MPE results.
3. The Numeric Gain calculated by $10^{(\text{ant. Gain(dBi)} / 10)}$.
4. The MPE results are evaluated by lowest data rate for WLAN.

Simultaneous Transmitting :

Total MPE = WWAN + 5GNR +WLAN 2.4GHz +WLAN 5GHz = 0.546 (mW)/cm² < 1 (mW)/cm²

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