

Maximum Permissible Exposure Report

Product Information

EUT :Mini PC
 Model Number :M1AA
 Model Declaration :NA
 Test Model :M1AA
 Power Supply :DC 19 by Adapter
 Hardware version :NUCAL02_MB_V30
 Software version :Windows 11
 Sample ID :TZ230904884-1# TZ230904884-2#

Bluetooth

Channel Number :79 Channels for Bluetooth BR/EDR(DSS)
 :40 Channels for BLE (DTS)
 Modulation Technology :GFSK, π/4-DQPSK, 8-DPSK for Bluetooth BR/EDR (DSS)
 :GFSK for BLE (DTS)
 Data Rates :Bluetooth BR/EDR (DSS): 1/2/3Mbps
 :BLE (DTS): 1/2Mbps
 Antenna Type And Gain :Internal Antenna /1.23dBi(Max.)

WiFi

WLAN :Supported IEEE 802.11b/g/n/ax
 WLAN FCC Operation Frequency :IEEE 802.11b:2412-2462MHz
 :IEEE 802.11g:2412-2462MHz
 :IEEE 802.11n HT20:2412-2462MHz
 :IEEE 802.11n HT40:2422-2452MHz
 :IEEE 802.11ax VHT20: 2412-2462MHz
 :IEEE 802.11ax VHT40: 2422-2452MHz
 WLAN Channel Number :11 Channels for 2412-2462MHz(IEEE 802.11b/g/n/ax HT20)
 :7 Channels for 2422-2452MHz(IEEE 802.11n/ax HT40)
 WLAN Modulation Technology :IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK)
 :IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK)
 :IEEE 802.11n: OFDM (64QAM, 16QAM,QPSK,BPSK)
 :IEEE 802.11ax: OFDM (256QAM, 64QAM, 16QAM, 1024QAM, QPSK, BPSK)
 Antenna Type And Gain :Internal Antenna1:1.23 dBi
 :Internal Antenna2:1.47 dBi

Note 1: Antenna position refer to EUT Photos
 Note 2: The above information supplied by the applicant
 Note 3: Models difference

Model	CPU
M1AA	i5
M1AA	i7
The main test is M1AA (i7)	

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 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 1 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

This Product can only use antennas certificated as follows provided by manufacturer;
 Antenna Gain and type refer to Product information

6. Conducted Power

2.4G Band:

Bluetooth(BDR+EDR)

TestMode	Antenna	Channel	Result[dBm]
DH5	Ant1	2402	5.85
		2441	6.02
		2480	5.58
2DH5	Ant1	2402	2.98
		2441	3.14
		2480	3.19
3DH5	Ant1	2402	2.29
		2441	2.96
		2480	3.06

Bluetooth(BLE)

TestMode	Antenna	Channel	Result[dBm]
BLE_1M	Ant1	2402	3.50
		2440	2.88
		2480	3.11
BLE_2M	Ant1	2402	5.95
		2440	5.39
		2480	5.60

WiFi 2.4GHz Band

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	16.13	≤30	PASS
	Ant1	2437	16.13	≤30	PASS
	Ant1	2462	16.09	≤30	PASS
11G	Ant1	2412	19.27	≤30	PASS
	Ant1	2437	19.52	≤30	PASS
	Ant1	2462	19.58	≤30	PASS
11N20MIMO	Ant1	2412	19.93	≤30	PASS
	Ant1	2437	20.23	≤30	PASS
	Ant1	2462	20.2	≤30	PASS
11N40MIMO	Ant1	2422	21.22	≤30	PASS
	Ant1	2437	21.32	≤30	PASS
	Ant1	2452	21.25	≤30	PASS

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
11B	Ant2	2412	15.8	≤30	PASS
	Ant2	2437	15.84	≤30	PASS
	Ant2	2462	15.9	≤30	PASS
11G	Ant2	2412	18.93	≤30	PASS
	Ant2	2437	19.19	≤30	PASS
	Ant2	2462	19.30	≤30	PASS
11N20MIMO	Ant2	2412	19.67	≤30	PASS
	Ant2	2437	19.99	≤30	PASS

11N40MIMO	Ant2	2462	19.95	≤30	PASS
	Ant2	2422	19.94	≤30	PASS
	Ant2	2437	20.14	≤30	PASS
	Ant2	2452	20.08	≤30	PASS

NII Band
Ant.1

Band	Channel	Frequency (MHz)	Conducted Power (dBm)	Duty Factor (dB)	Total Power (dBm)	Limit (dBm)	Verdict
20MHz(IEEE 802.11a/n/ac/ax)-worst							
1	Low	5180	12.42	1.11	13.53	21.65	Pass
	High	5240	12.12	1.02	13.14	21.65	Pass
2	Low	5260	12.08	1.04	13.12	21.65	Pass
	High	5320	12.25	1.04	13.29	21.65	Pass
3	Low	5500	11.97	1.11	13.08	21.65	Pass
	High	5700	12.73	1.02	13.75	21.65	Pass
4	Low	5745	12.57	1.09	13.66	27.65	Pass
	High	5825	12.13	1.32	13.45	27.65	Pass
40MHz(IEEE 802.11n/ac/ax)-worst							
1	Low	5190	13.13	1.58	14.71	21.65	Pass
	High	5230	13.82	1.62	15.44	21.65	Pass
2	Low	5270	13.57	1.5	15.07	21.65	Pass
	High	5310	12.34	1.58	13.92	21.65	Pass
3	Low	5510	12.08	1.54	13.62	21.65	Pass
	High	5670	14.21	1.63	15.84	21.65	Pass
4	Low	5755	13.87	1.54	15.41	27.65	Pass
	High	5795	13.63	3.07	16.7	27.65	Pass
80MHz(IEEE 802.11ac/ax)-worst							
1	Low	5210	12.65	2.91	15.56	21.65	Pass
2	High	5290	11.93	2.97	14.9	21.65	Pass
3	Low	5530	12.15	2.91	15.06	21.65	Pass
	High	5610	14.47	2.97	17.44	21.65	Pass
4	High	5775	13.64	2.98	16.62	21.65	Pass
160MHz(IEEE 802.11ax)-worst							
1	Low	5250	9.6	3.24	12.84	21.65	Pass
3	High	5570	10.16	3.49	13.65	21.65	Pass

Ant.2

Band	Channel	Frequency (MHz)	Conducted Power (dBm)	Duty Factor (dB)	Total Power (dBm)	Limit (dBm)	Verdict
20MHz(IEEE 802.11a/n/ac/ax)-worst							
1	Low	5180	12.04	1.4	13.44	22.76	Pass
	High	5240	11.01	1.48	12.49	22.76	Pass
2	Low	5260	11.1	1.46	12.56	22.76	Pass
	High	5320	11.79	1.44	13.23	22.76	Pass
3	Low	5500	11.7	1.42	13.12	22.76	Pass
	High	5700	12.73	1.09	13.82	22.76	Pass
4	Low	5745	12.5	1.04	13.54	28.76	Pass
	High	5825	12.07	1.42	13.49	28.76	Pass
40MHz(IEEE 802.11n/ac/ax)-worst							
1	Low	5190	12.62	2	14.62	22.76	Pass
	High	5230	13.24	1.92	15.16	22.76	Pass
2	Low	5270	13	1.92	14.92	22.76	Pass
	High	5310	11.86	1.92	13.78	22.76	Pass
3	Low	5510	11.83	1.93	13.76	22.76	Pass
	High	5670	13.98	1.89	15.87	22.76	Pass
4	Low	5755	13.5	1.97	15.47	28.76	Pass
	High	5795	13.37	1.53	14.9	28.76	Pass
80MHz(IEEE 802.11ac/ax)-worst							
1	Low	5210	12.59	2.97	15.56	22.76	Pass
2	High	5290	11.6	2.97	14.57	22.76	Pass
3	Low	5530	11.96	3.48	15.44	22.76	Pass
	High	5610	14.33	3.43	17.76	22.76	Pass
4	High	5775	13.34	3.44	16.78	22.76	Pass
160MHz(IEEE 802.11ax)-worst							
1	Low	5250	8.56	3.42	11.98	22.76	Pass
3	High	5570	9.81	3.5	13.31	22.76	Pass

7. Manufacturing Tolerance

Bluetooth(BDR+EDR)

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	5.5	5.5	5.0
Tolerance ±(dB)	1.0	1.0	1.0
π/4-DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	2.5	2.5	2.5
Tolerance ±(dB)	1.0	1.0	1.0
8-DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	2.0	2.5	2.5
Tolerance ±(dB)	1.0	1.0	1.0

Bluetooth(BLE)

GFSK(1Mbps) (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	3.0	2.5	2.5
Tolerance ±(dB)	1.0	1.0	1.0
GFSK(2Mbps) (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	5.5	5.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0

WiFi 2.4GHz Band – Antenna 1

IEEE 802.11b(Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	15.5	15.5	15.5
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11g (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	19.0	19.0	19.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11 n/ax20 (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	19.5	19.5	19.5
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11 n/ax 40 (Average)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	20.5	21.0	21.0
Tolerance ±(dB)	1.0	1.0	1.0

WiFi 2.4GHz Band – Antenna 2

IEEE 802.11b (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	11.5	11.5	11.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11g (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	11.0	10.5	10.5
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11 n/ax20 (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	11.0	10.5	10.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11 n/ax 40 (Average)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.5	10.5	10.0
Tolerance ±(dB)	1.0	1.0	1.0

UNII Band – Antenna 1

20MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5180 MHz	5240 MHz	5260 MHz
Target (dBm)	13.0	12.5	12.5
Tolerance \pm (dB)	1.0	1.0	1.0
20MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5320 MHz	5500 MHz	5700 MHz
Target (dBm)	13.0	12.5	13.5
Tolerance \pm (dB)	1.0	1.0	1.0
20MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5745 MHz	5825 MHz	--
Target (dBm)	13.0	13.0	--
Tolerance \pm (dB)	1.0	1.0	--

40MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5190 MHz	5230 MHz	5270 MHz
Target (dBm)	14.0	15.0	14.5
Tolerance \pm (dB)	1.0	1.0	1.0
40MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5310 MHz	5510 MHz	5670 MHz
Target (dBm)	13.5	13.0	15.5
Tolerance \pm (dB)	1.0	1.0	1.0
40MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5755 MHz	5795 MHz	--
Target (dBm)	15.0	16.0	--
Tolerance \pm (dB)	1.0	1.0	--

80MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5210 MHz	5290 MHz	5530 MHz
Target (dBm)	15.0	14.5	14.5
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT80 (Average)			
Channel	5610 MHz	5775 MHz	--
Target (dBm)	17.0	16.0	--
Tolerance \pm (dB)	1.0	1.0	--

160MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5250 MHz	5570 MHz	
Target (dBm)	12.5	13.0	
Tolerance \pm (dB)	1.0	1.0	

UNII Band – Antenna 1

20MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5180 MHz	5240 MHz	5260 MHz
Target (dBm)	13.0	12.0	12.0
Tolerance \pm (dB)	1.0	1.0	1.0
20MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5320 MHz	5500 MHz	5700 MHz
Target (dBm)	12.5	12.5	13.5
Tolerance \pm (dB)	1.0	1.0	1.0
20MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5745 MHz	5825 MHz	--
Target (dBm)	13.0	13.0	--
Tolerance \pm (dB)	1.0	1.0	--

40MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5190 MHz	5230 MHz	5270 MHz
Target (dBm)	14.0	15.0	14.5
Tolerance \pm (dB)	1.0	1.0	1.0
40MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5310 MHz	5510 MHz	5670 MHz
Target (dBm)	13.5	13.5	15.5
Tolerance \pm (dB)	1.0	1.0	1.0
40MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5755 MHz	5795 MHz	--
Target (dBm)	15.0	14.5	--
Tolerance \pm (dB)	1.0	1.0	--

80MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5210 MHz	5290 MHz	5530 MHz
Target (dBm)	15.0	14.0	15.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT80 (Average)			
Channel	5610 MHz	5775 MHz	--
Target (dBm)	17.5	16.5	--
Tolerance \pm (dB)	1.0	1.0	--

160MHz(IEEE 802.11a/n/ac/ax) (Average)			
Channel	5250 MHz	5570 MHz	
Target (dBm)	11.5	13.0	
Tolerance \pm (dB)	1.0	1.0	

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.

Bluetooth(BDR+EDR)

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
GFSK	6.5	4.4668	1.23	1.3274	100%	0.0012	1.0000
$\pi/4$ -DQPSK	3.5	2.2387	1.23	1.3274	100%	0.0006	1.0000
8-DPSK	3.5	2.2387	1.23	1.3274	100%	0.0006	1.0000

Bluetooth(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(1Mbps)	4.0	2.5119	1.23	1.3274	100%	0.0007	1.0000
GFSK(2Mbps)	0.0	1.0000	1.23	1.3274	100%	0.0003	1.0000

WiFi 2.4GHz Band – 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	16.5	44.6684	1.23	1.3274	100%	0.0118	1.0000
IEEE 802.11g	20.0	100.0000	1.23	1.3274	100%	0.0264	1.0000
20MHz(IEEE 802.11n/ax)	20.5	112.2018	1.23	1.3274	100%	0.0296	1.0000
40MHz(IEEE 802.11n/ax)	22.0	158.4893	1.23	1.3274	100%	0.0419	1.0000

WiFi 2.4GHz Band – Ant 2

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	16.5	44.6684	1.47	1.4028	100%	0.0125	1.0000
IEEE 802.11g	20.0	100.0000	1.47	1.4028	100%	0.0279	1.0000
20MHz(IEEE 802.11n/ax)	20.5	112.2018	1.47	1.4028	100%	0.0313	1.0000
40MHz(IEEE 802.11n/ax)	20.5	112.2018	1.47	1.4028	100%	0.0313	1.0000

UNII Band – 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					
20MHz(IEEE 802.11a/n/ac/ax)	14.5	28.1838	8.35	6.8391	100%	0.0384	1.0000
40MHz(IEEE 802.11n/ac/ax)	17.0	50.1187	8.35	6.8391	100%	0.0682	1.0000
80MHz(IEEE 802.11ac/ax)	18.0	63.0957	8.35	6.8391	100%	0.0859	1.0000
160MHz(IEEE 802.11ax)	14.0	25.1189	8.35	6.8391	100%	0.0342	1.0000

UNII Band – Ant 2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
20MHz(IEEE 802.11a/n/ac/ax)	14.5	28.1838	7.24	5.2966	100%	0.0297	1.0000
40MHz(IEEE 802.11n/ac/ax)	16.5	44.6684	7.24	5.2966	100%	0.0471	1.0000
80MHz(IEEE 802.11ac/ax)	18.5	70.7946	7.24	5.2966	100%	0.0746	1.0000
160MHz(IEEE 802.11ax)	14.0	25.1189	7.24	5.2966	100%	0.0265	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

Bluetooth + Wi-Fi

Maximum MPE Ratio BT/WIFI Ant.1	Maximum MPE Ratio WIFI Ant.2	Σ MPE	Limit	Results
0.0859	0.0746	0.1605	1.0000	PASS

Remark:

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

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-----