



RF EXPOSURE EVALUATION REPORT

APPLICANT : Thundercomm Technology Co., Ltd
PRODUCT NAME : Turbox C404 SOM
MODEL NAME : TurboX C404
BRAND NAME : TurboX
FCC ID : 2AOHH-TURBOXC404
STANDARD(S) : FCC 47CFR Part 2(2.1091)
RECEIPT DATE : 2021-07-29
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Edited by: Zeng Xiaoying
Zeng Xiaoying (Rapporteur)

Approved by: Shen Junsheng
Shen Junsheng (Supervisor)

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Change History		
Version	Date	Reason for Change
1.0	2021-09-23	First edition



1. Technical Information

Note: Provide by applicant.

1.1 Applicant and Manufacturer Information

Applicant:	Thundercomm Technology Co., Ltd
Applicant Address:	Building 4, No. 99, Data Valley Middle Road, Xiantao District, Yubei District, Chongqing, China
Manufacturer:	Thundercomm Technology Co., Ltd
Manufacturer Address:	Building 4, No. 99, Data Valley Middle Road, Xiantao District, Yubei District, Chongqing, China

1.2 Equipment under Test (EUT) Description

Product Name:	Turbox C404 SOM	
Sample No.:	2#	
Hardware Version:	TurboX C404 SOM V06	
Software Version:	LE1	
Frequency Bands:	Bluetooth	2402MHz-2480MHz
	WLAN 2.4GHz	2412MHz-2462MHz
	WLAN 5GHz	5180MHz-5240MHz
		5260MHz-5320MHz
		5500MHz-5720MHz
5745MHz-5825MHz		
Modulation Mode:	Bluetooth	GFSK(1Mbps), $\pi/4$ -DQPSK(EDR 2Mbps), 8-DPSK(EDR 3Mbps)
	WLAN 2.4GHz	DSSS, OFDM
	WLAN 5GHz	OFDM
Antenna Information:	Bluetooth	
	Antenna Type A	
	Antenna Type:	ANT3: PIFA Antenna
	Antenna Gain:	ANT3: 2.88dBi
	Antenna Type B	
	Antenna Type:	ANT3: PIFA Antenna
	Antenna Gain:	ANT3: 2.88dBi

Antenna Information:	WLAN 2.4GHz	
	Antenna Type A	
	Antenna Type:	ANT1: Dipole Antenna
		ANT2: Dipole Antenna
	Antenna Gain:	ANT1: 3.00dBi
		ANT 2: 3.00dBi
	Antenna Type B	
	Antenna Type:	ANT1: PIFA Antenna
		ANT2: PIFA Antenna
	Antenna Gain:	ANT1: 3.49dBi
		ANT 2: 3.51dBi
	WLAN 5GHz	
	Antenna Type A	
	Antenna Type:	ANT1: Dipole Antenna
		ANT2: Dipole Antenna
Antenna Gain:	ANT1: 4.00dBi	
	ANT 2: 4.00dBi	
Antenna Type B		
Antenna Type:	ANT1: PIFA Antenna	
	ANT2: PIFA Antenna	
Antenna Gain:	ANT1: 5.52dBi	
	ANT 2: 5.55dBi	

Note 1: This is a variant report of original report (Report No.: SZ20090290S01, FCC ID: 2AOHHTURBOXC404). Based on the similarity between before, made the following changes:

1. The Bluetooth function in the original ANT1 antenna port was changed to the ANT3 antenna port through software, and a new BT antenna was provided on the ANT3 port. The antenna gain is smaller than that of the original ANT1 port, and the antenna type is the same.
2. The back of the prototype PCB is optimized for heat dissipation, and some windows are added to the large area ground on the surface of the PCB.
3. Modify FCC ID number.

Except for the differences shown above, the other parts are the same as before. Their electrical circuit design, layout, components used and internal wiring are identical. No other changes. The changes only affect the results of Bluetooth in this report.

Note 2: The EUT will not sell with antenna.

Note 3: The EUT supports two type of antenna and each type of antenna has two antennas. Two type of antenna were considered and evaluated respectively by performing full test, only the worst data(Type B) were recorded and reported.



1.3 Applied Reference Documents

Leading reference documents for testing:

Identity	Document Title	Method determination /Remark
FCC 47CFR Part 2(2.1091)	Radio Frequency Radiation Exposure Assessment: mobile devices	No deviation
KDB 447498 D01v06	General RF Exposure Guidance	No deviation

Note 1: Additions to, deviation, or exclusions from the method shall be judged in the "method determination" column of add, deviate or exclude from the specific method shall be explained in the "Remark" of the above table.

Note 2: When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.



2. Device Category and RF Exposure Limit

Per user manual, Based on 47CFR 2.1091, this device belongs to mobile device category with General Population/Uncontrolled exposure.

Mobile Devices:

47CFR 2.1091(b)

For purposes of this section, a mobile device is defined 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 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. In this context, the term "fixed location" means that the device is physically secured at one location and is not able to be easily moved to another location. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20 centimeter separation requirement.

General Population/Uncontrolled Exposure:

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

Table 1—Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(B) Limits for General Population/Uncontrolled Exposure				
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/1500	30
1500-100,000	-	-	1.0	30

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



3. RF Output Power

Mode	Channel	Frequency (MHz)	Average power (dBm)
			GFSK
Bluetooth LE (1Mbps)	CH 00	2402	1.44
	CH 19	2440	2.39
	CH 39	2480	1.22
Tune-up Limit			3.00
Bluetooth LE (2Mbps)	CH 00	2402	0.28
	CH 19	2440	0.90
	CH 39	2480	0.01
Tune-up Limit			1.50

Mode	Channel	Frequency (MHz)	Average power (dBm)		
			GFSK	$\pi/4$ -DQPSK	8-DPSK
Bluetooth classic	CH 00	2402	1.83	1.98	2.05
	CH 39	2441	1.00	1.06	2.60
	CH 78	2480	2.34	2.48	2.48
Tune-up Limit			2.50	3.00	3.00



2.4GHz WLAN, ANT1					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11b	CH 1	2412	16.21	17.00	97.76
	CH 6	2437	16.99	17.50	
	CH 11	2462	16.18	17.00	
802.11g	CH 1	2412	13.91	14.50	98.31
	CH 6	2437	14.66	15.00	
	CH 11	2462	13.88	14.50	

2.4GHz WLAN, ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11b	CH 1	2412	16.43	17.00	97.76
	CH 6	2437	16.81	17.50	
	CH 11	2462	16.23	17.00	
802.11g	CH 1	2412	14.03	14.50	98.31
	CH 6	2437	14.40	15.00	
	CH 11	2462	13.82	14.50	

2.4GHz WLAN, ANT1+ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11n (HT20)	CH 1	2412	15.80	16.50	98.18
	CH 6	2437	16.23	16.50	
	CH 11	2462	15.80	16.50	
802.11n (HT40)	CH 3	2422	16.43	17.00	94.90
	CH 6	2437	16.99	17.50	
	CH 9	2452	16.81	17.50	



5GHz WLAN, ANT1					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11a	CH 36	5180	15.25	15.50	97.67
	CH 44	5220	15.06	15.50	
	CH 48	5240	14.88	15.50	
	CH 52	5260	14.79	15.50	
	CH 60	5300	14.81	15.50	
	CH 64	5320	14.66	15.50	
	CH 100	5500	14.70	15.50	
	CH 120	5600	14.88	15.50	
	CH 144	5720	14.90	15.50	
	CH 149	5745	14.39	15.00	
	CH 157	5785	14.76	15.50	
	CH 165	5825	15.17	15.50	

5GHz WLAN, ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11a	CH 36	5180	15.82	16.50	97.67
	CH 44	5220	15.43	16.00	
	CH 48	5240	16.02	16.50	
	CH 52	5260	15.36	16.00	
	CH 60	5300	15.50	16.00	
	CH 64	5320	15.45	16.00	
	CH 100	5500	15.70	16.50	
	CH 120	5600	15.38	16.00	
	CH 144	5720	15.50	16.00	
	CH 149	5745	15.45	16.00	
	CH 157	5785	15.18	16.00	
	CH 165	5825	15.60	16.00	



5GHz WLAN, ANT1+ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11n (HT20)	CH 36	5180	18.33	18.50	97.51
	CH 44	5220	18.20	18.50	
	CH 48	5240	18.33	18.50	
	CH 52	5260	18.06	18.50	
	CH 60	5300	18.33	18.50	
	CH 64	5320	18.26	18.50	
	CH 100	5500	18.13	18.50	
	CH 120	5600	18.20	18.50	
	CH 144	5720	18.13	18.50	
	CH 149	5745	17.85	18.50	
	CH 157	5785	18.06	18.50	
	CH 165	5825	18.20	18.50	

5GHz WLAN, ANT1+ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11n (HT40)	CH 38	5190	18.57	19.00	95.87
	CH 46	5230	18.45	19.00	
	CH 54	5270	18.39	18.50	
	CH 62	5310	18.26	18.50	
	CH 102	5510	18.26	18.50	
	CH 126	5630	18.33	18.50	
	CH 142	5710	18.20	18.50	
	CH 151	5755	18.13	18.50	
	CH 159	5795	18.45	19.00	



5GHz WLAN, ANT1+ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11ac (VHT20)	CH 36	5180	18.45	19.00	98.19
	CH 44	5220	18.45	19.00	
	CH 48	5240	18.33	18.50	
	CH 52	5260	18.13	18.50	
	CH 60	5300	18.06	18.50	
	CH 64	5320	18.06	18.50	
	CH 100	5500	18.06	18.50	
	CH 120	5600	17.99	18.50	
	CH 144	5720	17.99	18.50	
	CH 149	5745	17.92	18.50	
	CH 157	5785	18.20	18.50	
CH 165	5825	18.33	18.50		

5GHz WLAN, ANT1+ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11ac (VHT40)	CH 38	5190	18.51	19.00	96.39
	CH 46	5230	18.45	19.00	
	CH 54	5270	18.39	19.00	
	CH 62	5310	18.45	19.00	
	CH 102	5510	18.45	19.00	
	CH 126	5630	18.69	19.00	
	CH 142	5710	18.57	19.00	
	CH 151	5755	18.51	19.00	
	CH 159	5795	18.57	19.00	



5GHz WLAN, ANT1+ANT2					
Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-up Power	Duty Cycle %
802.11ac (VHT80)	CH 42	5210	18.51	19.00	96.39
	CH 58	5290	18.06	18.50	
	CH 106	5530	18.57	19.00	
	CH 122	5610	18.45	19.00	
	CH 138	5690	18.06	18.50	
	CH 155	5775	17.56	18.00	

Note 1: According to KDB 447498 Section 4.3, MPE assessment is based on source-based time-averaged maximum conducted output power of the RF channel requiring assessment, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions.

Note 2: The output power refers to report (Report No.: SZ21070280W01/W02/W03/W04).

4. RF Exposure Assessment

➤ Standalone Transmission Assessment:

Bands	Frequency (MHz)	Tune-up Power(dBm)	Antenna Gain(dBi)	E.I.R.P. (mW)	Power Density (mW/cm ²)	Limit for MPE (mW/cm ²)
Bluetooth	2441	3.00	2.88	3.87	0.001	1.0
WLAN 2.4GHz ANT1	2437	17.50	3.49	125.60	0.025	1.0
WLAN 2.4GHz ANT2	2437	17.50	3.51	126.18	0.025	1.0
WLAN 5GHz ANT1	5180	15.50	5.52	126.47	0.025	1.0
WLAN 5GHz ANT2	5320	16.50	5.55	160.32	0.032	1.0

➤ MIMO Transmission Assessment

Bands	Frequency (MHz)	Tune-up Power(dBm)	Antenna Gain(dBi)	E.I.R.P. (mW)	Power Density (mW/cm ²)	Limit for MPE (mW/cm ²)
WLAN 2.4GHz	2437	17.50	3.51	126.18	0.025	1.0
WLAN 5GHz	5630	19.00	5.55	285.10	0.057	1.0

Note 1: For 2.4G/5G WLAN, only the worst case will be used for calculating the power density.

Note 2: MPE calculate method

$$\text{Power Density} = \text{E.I.R.P.}/4\pi R^2$$

Where: E.I.R.P. = P+G

P = Output Power (dBm)

G = Antenna Gain (dBi)

R = Separation Distance (20cm)

➤ **Simultaneous Transmission Assessment:**

Multi-Band Simultaneous Transmission Consideration

Simultaneous Transmission Consideration	Position	Applicable Combination
	Hand/Body	WLAN 2.4GHz(ANT2)+ Bluetooth
		WLAN 5GHz(ANT2)+ Bluetooth
		WLAN 2.4GHz(ANT1)+ WLAN 5GHz(ANT2)
WLAN 5GHz(ANT1)+ WLAN 2.4GHz(ANT2)		

Note 1: This device contains transmitters that may operate simultaneously, therefore simultaneous transmission analysis is required as below.

Applicable Combination	Transmission Bands	Power Density (mW/cm ²)	Limit (mW/cm ²)	Simultaneous Transmission Result
WLAN 2.4GHz (ANT2)+ Bluetooth	WLAN 2.4GHz (ANT2)	0.025	1.0	0.026
	Bluetooth	0.001	1.0	
WLAN 5GHz (ANT2)+ Bluetooth	WLAN 2.4GHz (ANT2)	0.032	1.0	0.033
	Bluetooth	0.001	1.0	
WLAN 2.4GHz(ANT1)+ WLAN 5GHz(ANT2)	WLAN 2.4GHz (ANT1)	0.025	1.0	0.057
	WLAN 5GHz (ANT2)	0.032	1.0	
WLAN 5GHz(ANT1)+ WLAN 2.4GHz(ANT2)	WLAN 5GHz (ANT1)	0.025	1.0	0.050
	WLAN 2.4GHz (ANT2)	0.025	1.0	

Note 1: Formula for result=Power density₁/ limit₁ + Power density₂/ limit₂ ≤ 1.
Note 2: The black bold applicable combination was the worst condition.

➤ **Conclusion:**

According to 47 CFR §2.1091, this device complies with human exposure basic restrictions.



Annex A Testing Laboratory Information

1. Identification of the Responsible Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Laboratory Address:	FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, Guangdong Province, P. R. China
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

2. Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Address:	FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, Guangdong Province, P. R. China

3. Facilities and Accreditations

All measurement facilities used to collect the measurement data are located at FL.3, Building A, FeiYang Science Park, Block 67, BaoAn District, Shenzhen, 518101 P. R. China. The test site is constructed in conformance with the requirements of ANSI C63.10-2013 and CISPR Publication 22; the FCC designation number is CN1192, the test firm registration number is 226174.

_____ END OF REPORT _____