FCC RF Exposure Evaluation

1. Product Information

FCC ID	2ALVGETCS2A
Product name	Andromeda
Model number	ETCS2A-M2
Power supply	Input 3.6Vdc, 0.5A Max(Supply by 3.6V/12Ah Li/SOCl2 battery)
EUT Type	Production Unit
Device Type	Mobile Devices

Bluetooth		
Frequency Range	:	2402MHz-2480MHz
Bluetooth Channel Number	:	40 channels for Bluetooth V5.0 (DTS)
Bluetooth Channel Spacing	:	2MHz for Bluetooth V5.0 (DTS)
Bluetooth Modulation Type	:	GFSK for Bluetooth V5.0 (DTS)
Bluetooth Version	:	V5.0
Antenna Description	:	PCB Antenna, 0.8dBi(Max.)
2.4G WLAN		
Frequency Range	:	2412 – 2462 MHz
Channel Number	:	11 Channels for 20MHz bandwidth (2412~2462MHz)
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)
Antenna Description	:	PCB Antenna, 0.6dBi(Max.)
LTE	:	
Support Band	:	☒E-UTRA Band 12(U.S.-Band) ☒E-UTRA Band 25(U.S.-Band)
LTE Release Version	:	R8
Type Of Modulation	:	QPSK/16QAM
Antenna Description	:	Internal Antenna 0dBi (max.) For E-UTRA Band 12 0dBi (max.) For E-UTRA Band 25
Power Class	:	Class 3
M2-24	:	
Operating Frequency	:	Uplink: 399.9 ~ 400.05MHz Downlink: 400.15 to 401MHz
Modulation Type	:	MSK
Emission Designator	:	4K27G1D

Antenna Type	:	Internal Antenna
Antenna Gain	:	-1.58dBi (max.)
GPS function	:	Support and only RX

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

Artemis Antenna can only use antennas certificated as follows provided by manufacturer;

Internal Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Note
Antenna	PCB Antenna	2400MHz-2500MHz	0.8dBi	BT Antenna
Antenna	PCB Antenna	2400MHz-2500MHz	0.6dBi	WIFI Antenna
Antenna	Internal Antenna	699MHz -716MHz 1850MHz -1915MHz	0dBi	LTE Antenna
Antenna	Internal Antenna	399.9 ~ 400.05	-1.58dBi	M2-24 Antenna

6. Conducted Power

< BT LE Max Conducted Power >

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
GFSK	0	2402	-3.11
	19	2440	-2.72
	39	2480	-2.61

< BT 2LE Max Conducted Power >

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
GFSK	0	2402	-3.06
	19	2440	-2.35
	39	2480	-2.6

<2.4GWLAN Max Conducted Power >

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
IEEE 802.11b	1	2412	11.94
	6	2437	11.67
	11	2462	11.02
IEEE 802.11g	1	2412	10.25
	6	2437	10.13
	11	2462	9.30
IEEE 802.11n HT20	1	2412	10.28
	6	2437	10.13
	11	2462	9.29

[LTE Max Average Power]

Test Mode		**Channel**	**Max Average Power (dBm)**
LTE	Band 12	LCH	19.88
		MCH	20.62
		HCH	19.78
	Band 25	LCH	21.54
		MCH	22.79
		HCH	22.61

<M2-24>

Test Mode	**Frequency(MHz)**	**Max Conducted Peak Power (dBm)**
MSK	399.975	28.911

7. Manufacturing Tolerance

<BT LE>

GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	-3.0	-2.0	-2.0
Tolerance ±(dB)	1.0	1.0	1.0

<BT 2LE>

GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	-3.0	-2.0	-2.0
Tolerance ±(dB)	1.0	1.0	1.0

<2.4G WIFI>

11B (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	11.0	11.0	11.0
Tolerance ±(dB)	1.0	1.0	1.0
11G (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	10.0	9.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20SISO (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	10.0	9.0
Tolerance ±(dB)	1.0	1.0	1.0

<LTE Max Average Power>

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 12	LCH	19.88	20.0±1.0
		MCH	20.62	20.0±1.0
		HCH	19.78	20.0±1.0
	Band 25	LCH	21.54	22.0±1.0
		MCH	22.79	22.0±1.0
		HCH	22.61	22.0±1.0

<M2-24>

Test Mode	Frequency(MHz)	Max Conducted Peak Power (dBm)	Tune Up Power (dBm)
MSK	399.975	28.911	29.0±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 =20cm, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

[Antenna]

<BT LE>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm2)	MPE Limits (mW/cm2)
	dBm	mW			
GFSK	-1.0	0.7943	0.8	0.0002	1.0000

<BT 2LE>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm2)	MPE Limits (mW/cm2)
	dBm	mW			
GFSK	-1.0	0.7943	0.8	0.0002	1.0000

<2.4G WIFI>

Band/Mode	RF output power		Antenna Gain (dBi)	MPE (mW/cm2)	MPE Limits (mW/cm2)
	dBm	mW			
IEEE 802.11b	12.0	15.8489	0.6	0.0036	1.0000
IEEE 802.11g	11.0	12.5893	0.6	0.0029	1.0000
IEEE 802.11n HT20	11.0	12.5893	0.6	0.0029	1.0000

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm2)	MPE Limits (mW/cm2)
	dBm	mW				
LTE Band 12	21.00	125.8925	0	1.0000	0.0250	0.466
LTE Band 25	23.00	199.5262	0	1.0000	0.0397	1.0000

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm2)	MPE Limits (mW/cm2)
	dBm	mW				
MSK 410 ~ 470MHz	30.00	1000	-1.58	0.6950	0.1383	0.2733

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 support one 2.4GWLAN, another one LTE CatM1 , another one VHF(TX) and another one BT transmit antenna, so need consider simultaneous transmission;
Simultaneous transmission MPE
According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
∑∑of MPE ratios ≤ 1.0

BLE+2.4GWLAN+ LTE CatM1+M2-24			
Mode	**∑ MPE ratios**	**Limit**	**Results**
BLE+2.4GWLAN+ LTE CatM1+M2-24	0.690919	1.000	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.....