Maximum Permissible Exposure Report

1. Product Information

FCC ID	:	2AU4T-TM18NA
EUT	:	4G module
Test Model	:	TM18NA
Power Supply	:	DC 3.3~4.3V
Hardware Version	:	/
Software Version	:	/
LTE		
Support Band	:	☒E-UTRA Band 2(U.S.-Band) ☒E-UTRA Band 4(U.S.-Band) ☒E-UTRA Band 5(U.S.-Band) ☒E-UTRA Band 7(U.S.-Band) ☒E-UTRA Band 12(U.S.-Band) ☒E-UTRA Band 13(U.S.-Band) ☒E-UTRA Band 17(U.S.-Band) ☒E-UTRA Band 26(U.S.-Band) ☒E-UTRA Band 41(U.S.-Band) ☒E-UTRA Band 66(U.S.-Band)
LTE Release Version	:	R13
Type Of Modulation	:	QPSK/16QAM
Antenna Description	:	External Antenna 0dBi (max.) For E-UTRA Band 2 0dBi (max.) For E-UTRA Band 4 0dBi (max.) For E-UTRA Band 5 0dBi (max.) For E-UTRA Band 7 0dBi (max.) For E-UTRA Band 12 0dBi (max.) For E-UTRA Band 13 0dBi(max.) For E-UTRA Band 17 0dBi (max.) For E-UTRA Band 26 0dBi (max.) For E-UTRA Band 41 0dBi(max.) For E-UTRA Band 66
Power Class	:	Class 3
Exposure category	:	General population/uncontrolled environment
EUT Type	:	Production Unit
Device Type	:	Mobile Devices

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 C95.1–2019: IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz 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.
FCC CFR 47 part22 22.913: The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts.
FCC CFR 47 part24 24.232: Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.
FCC CFR 47 part24 24.232: Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.
FCC CFR 47 part27 27.50: Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP; Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP; Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP. Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications; Fixed, mobile, and portable (hand-held) stations operating in the 2000-2020 MHz band are limited to 2 watts EIRP, except that the total power of any portion of an emission that falls within the 2000-2005 MHz band may not exceed 5 milliwatts. A licensee of AWS-4 authority may enter into private operator-to-operator agreements with all 1995-2000 MHz licensees to operate in 2000-2005 MHz at power levels above 5 milliwatts EIRP; except the total power of the AWS-4 mobile emissions may not exceed 2 watts EIRP; Mobile stations are limited to 2.0 watts EIRP. All user stations are limited to 2.0 watts transmitter output power.
FCC CFR 47 part90 90.635: The maximum output power of the transmitter for mobile stations is 100 watts (20 dBw).

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/f2)*	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/Uncontrolled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 30	824/f	2.19/f	(180/f2)*	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

EUT can only use antennas certificated as follows provided by manufacturer;

Internal/External Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Notes
External	External Antenna	600-2700MHz	0dBi	LTE Antenna

6. Conducted Power

[LTE Maximum Average Power]

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 2	Low	21.31	22.0±1.0
		Middle	21.54	22.0±1.0
		High	22.72	22.0±1.0
	Band 4	Low	20.72	21.0±1.0
		Middle	21.33	21.0±1.0
		High	21.15	21.0±1.0
	Band 5	Low	23.44	23.0±1.0
		Middle	23.55	23.0±1.0
		High	23.68	23.0±1.0
	Band 7	Low	21.77	21.0±1.0
		Middle	21.79	21.0±1.0
		High	21.43	21.0±1.0
	Band 12	Low	23.71	23.0±1.0
		Middle	23.58	23.0±1.0
		High	23.61	23.0±1.0
	Band 13	Low	24.01	24.0±1.0
		Middle	23.80	24.0±1.0
		High	23.80	24.0±1.0
	Band 17	Low	23.65	23.0±1.0
		Middle	23.66	23.0±1.0
		High	23.58	23.0±1.0
	Band 26S1	Low	23.26	23.0±1.0
		Middle	23.30	23.0±1.0
		High	23.20	23.0±1.0
	Band 26S2	Low	23.34	23.0±1.0
		Middle	23.24	23.0±1.0
		High	23.06	23.0±1.0
	Band 41	Low	21.50	21.0±1.0
		Middle	21.86	21.0±1.0
		High	21.41	21.0±1.0
	Band 66	Low	22.29	22.0±1.0
		Middle	22.62	22.0±1.0
		High	22.45	22.0±1.0

7. Measurement Results

7.1 Standalone MPE Evaluation

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.

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
LTE Band 2	23.00	199.5262	0	1.0000	0.0397	1.0000
LTE Band 4	22.00	158.4893	0	1.0000	0.0315	1.0000
LTE Band 5	24.00	251.1886	0	1.0000	0.0500	0.5493
LTE Band 7	22.00	158.4893	0	1.0000	0.0315	1.0000
LTE Band 12	24.00	251.1886	0	1.0000	0.0500	0.4660
LTE Band 13	25.00	316.2278	0	1.0000	0.0629	0.5180
LTE Band 17	24.00	251.1886	0	1.0000	0.0500	0.4693
LTE Band 26S1	24.00	251.1886	0	1.0000	0.0500	0.5427
LTE Band 26S2	24.00	251.1886	0	1.0000	0.0500	0.5493
LTE Band 41	22.00	158.4893	0	1.0000	0.0315	1.0000
LTE Band 66	23.00	199.5262	0	1.0000	0.0397	1.0000

Remark:
1. Output power including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.
4. Use lowest frequency to calculate limits (lowest limits).

7.2 Simultaneous Transmission MPE Evaluation

The EUT only used one cellular modular and antenna, no need considers simultaneous transmission.

7.3 Maximum Antenna Gain Calculations

Modulation Type	Output power		ERP/EIRP Calculations			MPE Calculations			Maximum Antenna Gain (dBi)
	dBm	mW	ERP/EIRP Limits (dBm)	Maximum Antenna Gain (G1)		MPE Limits (mW/cm^2)	Maximum Antenna Gain (G2)		
				dBi	linear		dBi	linear	
LTE Band 2	23.00	199.5262	33.01	10.01	10.0231	1.0000	14.01	25.1796	10.01
LTE Band 4	22.00	158.4893	30.00	8.00	6.3096	1.0000	15.01	31.6993	8.00
LTE Band 5	24.00	251.1886	38.45	16.60	45.7088	0.5493	10.41	10.9865	10.41
LTE Band 7	22.00	158.4893	33.01	11.01	12.6183	1.0000	15.01	31.6993	11.01
LTE Band 12	24.00	251.1886	34.77	12.92	19.5884	0.4660	9.69	9.3204	9.69
LTE Band 13	25.00	316.2278	34.77	11.92	15.5597	0.5180	9.15	8.2296	9.15
LTE Band 17	24.00	251.1886	34.77	12.92	19.5884	0.4693	9.73	9.3864	9.73
LTE Band 26S1	24.00	251.1886	50.00	28.15	653.1306	0.5427	10.36	10.8545	10.36
LTE Band 26S2	24.00	251.1886	38.45	16.60	45.7088	0.5493	10.41	10.9865	10.41
LTE Band 41	22.00	158.4893	33.01	11.01	12.6183	1.0000	15.01	31.6993	11.01
LTE Band 66	23.00	199.5262	30.00	7.00	5.0119	1.0000	14.01	25.1796	7.00

Remark:
1. Output power including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.
4. Use lowest frequency to calculate limits (lowest limits).
5. EIRP (dBm) = Antenna Port Conducted Power (dBm) + Antenna Gain (dBi);
6. EIRP (dBm) = ERP (dBm) + 2.15;
7. G1 is name of maximum allow antenna gain calculation based on EIRP/ERP limits, G2 is name of maximum allow antenna gain calculation based on MPE limits.
8. Maximum Antenna Gain is minimum values of G1 and G2;

9. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

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