

Maximum Permissible Exposure Report

1. Product Information

Name of EUT	Battery Operated LTE Cellular GPS Tracker
Test Model	Arrow-QA
Additional Models	Arrow-QAC, 4-6350-17, 4-6350-10, 4-6351-17
Model Declaration	PCB board, structure, External and internal of these model(s) are the same, So no additional models were tested.
Power Supply	DC 12V, 1000mA
Hardware Version	P2.0.1
Software Version	2.8.2
Bluetooth	
Frequency Range	2402MHz-2480MHz
Channel Number	40 channels for Bluetooth V5.0 (BT LE)
Channel Spacing	2MHz for Bluetooth V5.0 (BT LE)
Modulation Type	GFSK for Bluetooth V5.0 (BT LE)
Antenna Description	Internal Antenna, 2.57dBi(Max.)
NB-IOT	Please Refer To FCC ID: XMR2020BG95M2
GPS	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

Arrow-QHC can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Notes
Internal Antenna	2400 MHz – 2500 MHz	2.57 dBi	BT

6. Conducted Power

[BLE Max Conducted Power]

Mode	Channel	Frequency(MHz)	Max Conducted Power (dBm)
GFSK	0	2402	-4.343
	19	2440	-4.868
	39	2480	-5.526

7. Manufacturing Tolerance

<BT LE>

GFSK (Peak)

Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	-4.0	-5.0	-5.0
Tolerance ±(dB)	1.0	1.0	1.0

8. Measurement Results

8.1 Standalone MPE Evaluation

8.1.1 BT LE

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.

[BT LE]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE (mW/cm ²)	MPE Ratio
	dBm	W					
GFSK	-3.0	0.0005	2.57	1.81	0.0002	1.0	0.0002

Remark:

1. Output power including turn-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer;
3. We choose the lowest frequency operate to calculate MPE limit as higher frequency will have higher MPE limits.
4. $MPE\ values = PG/4\pi R^2$

8.1.2 For LTE Cat M1 & Cat NB2 Module

Refer for FCC ID: XMR2020BG95M2 (Report Number: R1907A0448-M1V1)

Operate mode	Maximum Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Power density (W/m ²)		MPE Ratio
				Results	Limit	
LTE Band 2	22.000	11.000	33.000	0.3969	1.000	0.3969
LTE Band 4	22.000	8.000	30.000	0.1989	1.000	0.1989
LTE Band 5	22.000	9.100	31.100	0.2563	0.566	0.4528
LTE Band 12	22.000	8.612	30.612	0.2290	0.477	0.4801
LTE Band 13	22.000	8.926	30.926	0.2462	0.525	0.4690
LTE Band 25	22.000	11.000	33.000	0.3969	1.000	0.3969
LTE Band 26	22.000	9.064	31.064	0.2542	0.566	0.4491
LTE Band 66	22.000	8.000	30.000	0.1989	1.000	0.1989
LTE Band 85	22.000	8.608	30.608	0.2288	0.477	0.4797
NB-IOT Band 2	22.000	11.000	33.000	0.3969	1.000	0.3969
NB-IOT Band 4	22.000	8.000	30.000	0.1989	1.000	0.1989
NB-IOT Band5	22.000	9.100	31.100	0.2563	0.566	0.4528
NB-IOT Band 12	22.000	8.612	30.612	0.2290	0.477	0.4801
NB-IOT Band 13	22.000	8.926	30.926	0.2462	0.525	0.4690
NB-IOT Band25	22.000	8.968	30.968	0.2486	1.000	0.2486
NB-IOT Band 66	22.000	9.064	31.064	0.2542	1.000	0.2542
NB-IOT Band 71	22.000	8.000	30.000	0.1989	0.465	0.4277
NB-IOT Band 85	22.000	8.608	30.608	0.2288	0.477	0.4797

8.2 Simultaneous Transmission MPE

there are two antenna ports, one is for BT and the other is for NB-IOT. So BT and NB-IOT can transmit at the same time. According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

\sum of MPE ratios ≤ 1.0

MPE Ratio BT	MPE Ratio LTE	\sum MPE Ratio	Limit	MPE Exclusion
0.0002	0.4801	0.4803	1.0	yes

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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