

## Maximum Permissible Exposure Report

### Product Information

Product Name	: LoRa+BLE module
Model Number	: RAK4600(H)
Model Difference Declaration	: N/A
Test Model	: RAK4600(H)
Power Supply	: DC 3.3V
Hardware version	: Rev V00
Software version	: RAK4600_V3.0.0.8

#### LoRa

##### LoRa-Hybrid Mode

Frequency Range	: 902.3 – 914.9 MHz
Channel Number	: 64 Channels
Modulation Technology	: LORA

##### LoRa-DTS Mode

Frequency Range	: 903 – 914.2 MHz
Channel Number	: 8 Channels
Modulation Technology	: LORA

Antenna information : External Antenna / 3.0 dBi

#### Bluetooth

Bluetooth Version	: V5.0[only support LE Mode]
Channel Number	: 40 Channels for BLE (DTS)
Modulation Technology	: GFSK for BLE (DTS)
Data Rates	: BLE (DTS): 1Mbps/2Mbps
Antenna Type And Gain	External Antenna / 3.0 dBi

*Note: Antenna position refer to EUT Photos.*

## 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  $\leq 1.0$ . 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 <sup>2</sup> )	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 <sup>2</sup> )*	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 <sup>2</sup> )	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 <sup>2</sup> )*	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;

Internal Identification	Antenna Description	Antenna type and antenna number	Operate frequency band	Maximum antenna gain
Antenna 1	LoRa Antenna	External Antenna	902 MHz – 908 MHz	3.00 dBi
Antenna 2	BT Antenna	External Antenna	2402 MHz – 2480 MHz	3.00 dBi

## 6. Conducted Power

### LoRa-DTS Mode

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)
Lora-DTS	0	903.0	14.938
	3	907.8	14.934
	7	914.2	14.937

### LoRa-Hybrid Mode

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)
LoRa-Hybrid	00	902.3	9.961
	32	908.7	9.954
	63	914.9	9.948

### BT-BLE Mode

Test Mode	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)
GFSK(1Mbps)	00	2402	0.305
	19	2440	0.548
	39	2480	0.786
GFSK(2Mbps)	00	2402	0.409
	19	2440	0.620
	39	2480	0.844

## 7. Manufacturing Tolerance

### LoRa

LoRa-DTS Mode (Peak)			
Channel	Channel 0	Channel 33	Channel 64
Target (dBm)	14.5	14.5	14.5
Tolerance $\pm$ (dB)	1.0	1.0	1.0
LoRa-Hybrid Mode (Peak)			
Channel	Channel 0	Channel 33	Channel 64
Target (dBm)	9.0	9.0	9.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

### Bluetooth

GFSK(1Mbps) Mode (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	0.0	0.0	0.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
GFSK(2Mbps) (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	0.0	0.0	0.0
Tolerance $\pm$ (dB)	1.0	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.

Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm <sup>2</sup> )	MPE Limits (mW/cm <sup>2</sup> )
	dBm	mW					
LoRa-DTS	15.50	35.4813	3.00	1.9953	100%	0.0141	0.6013
LoRa-DSS	10.00	10.0000	3	1.9953	100%	0.0040	0.6013
GFSK(1Mbps)	1.00	1.2589	3.00	1.9953	100%	0.0005	1.0000
GFSK(2Mbps)	1.00	1.2589	3.00	1.9953	100%	0.0005	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

Maximum Simultaneous transmission MPE Ratios for Antenna 1 and Antenna 2

Maximum MPE(mW/cm <sup>2</sup> ) Ant.1	Maximum MPE(mW/cm <sup>2</sup> ) Ant.2	ΣMPE (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	Results
0.0141	0.0005	0.0146	0.6013	PASS

## 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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