

# 1 RF Exposure Compliance

## 1.1 Test Standards

Test standard : FCC 47 CFR Part 2 Section 2.1091  
RSS-102 Issue 5 Section 3.2

FCC ID:2AF6B-RAK7289C

Contains FCC ID: 2AF6B-RAK634, 2AF6B-RAK5146, XMR201807EG95NA

Contains IC: 25908-RAK634, 25908-RAK5146, 10224A-2018EG95NA

## 1.2 MPE Limits of FCC and IC

### MPE Limit for FCC

| Frequency range (MHz)                                          | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm <sup>2</sup> ) | Averaging time (minutes) |
|----------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| <b>(B) Limits for General Population/Uncontrolled Exposure</b> |                               |                               |                                     |                          |
| 0.3-1.34                                                       | 614                           | 1.63                          | *100                                | 30                       |
| 1.34-30                                                        | 824/f                         | 2.19/f                        | *180/f <sup>2</sup>                 | 30                       |
| 30-300                                                         | 27.5                          | 0.073                         | 0.2                                 | 30                       |
| 300-1,500                                                      |                               |                               | f/1500                              | 30                       |
| 1,500-100,000                                                  |                               |                               | 1.0                                 | 30                       |

### MPE Limit for IC

| Frequency Range (MHz)                                                                                                   | Electric Field (V/m rms)  | Magnetic Field (A/m rms)                 | Power Density (W/m <sup>2</sup> ) | Reference Period (minutes) |
|-------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------|-----------------------------------|----------------------------|
| 0.003-10 <sup>21</sup>                                                                                                  | 83                        | 90                                       | -                                 | Instantaneous*             |
| 0.1-10                                                                                                                  | -                         | 0.73/ f                                  | -                                 | 6**                        |
| 1.1-10                                                                                                                  | 87/ f <sup>0.5</sup>      | -                                        | -                                 | 6**                        |
| 10-20                                                                                                                   | 27.46                     | 0.0728                                   | 2                                 | 6                          |
| 20-48                                                                                                                   | 58.07/ f <sup>0.25</sup>  | 0.1540/ f <sup>0.25</sup>                | 8.944/ f <sup>0.5</sup>           | 6                          |
| 48-300                                                                                                                  | 22.06                     | 0.05852                                  | 1.291                             | 6                          |
| 300-6000                                                                                                                | 3.142 f <sup>0.3417</sup> | 0.008335 f <sup>0.3417</sup>             | 0.02619f <sup>0.6834</sup>        | 6                          |
| 6000-15000                                                                                                              | 61.4                      | 0.163                                    | 10                                | 6                          |
| 15000-150000                                                                                                            | 61.4                      | 0.163                                    | 10                                | 616000/ f <sup>1.2</sup>   |
| 150000-300000                                                                                                           | 0.158 f <sup>0.5</sup>    | 4.21 x 10 <sup>-4</sup> f <sup>0.5</sup> | 6.67 x 10 <sup>-5</sup> f         | 616000/ f <sup>1.2</sup>   |
| <b>Note:</b> f is frequency in MHz.<br>*Based on nerve stimulation (NS).<br>** Based on specific absorption rate (SAR). |                           |                                          |                                   |                            |

## 1.3 Test Result

Test Result: PASS

This device is mobile device, and the applicant declares that the minimum separation distance is greater than 20cm, detail minimum distance refer to below calculation table. Therefore MPE measurement or computational modeling should be used to determine compliance.

MPE Calculation is based on the conducted power, and considering maximum power and antenna gain. The following formula is used to MPE evaluation.

- (1) The power density according to far-field model is:

$$S = \frac{P \times G_{(\theta, \phi)}}{4 \times \pi \times R^2}$$

Where:

- $P$  = input power of the antenna.  
 $G$  = antenna gain relative to an isotropic antenna.  
 $\theta, \phi$  = elevation and azimuth angles.  
 $R$  = distance from the antenna to the point of investigation.

- (2) For single or multiple RF sources, the calculated power density should comply with following:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Where:

- $S_i$  = the power density when the  $f$  is  $i$ .  
 $S_{Limit,i}$  = the reference level requirement for power density when  $f$  is  $i$ .  
 $f$  = operating frequency.

### A. Stand-alone operation mode (worst mode)

| Operating Mode | Band       | PG (dBm) | PG (W)  | Calculation (mW/cm <sup>2</sup> ) | FCC Limit (mW/cm <sup>2</sup> ) | Verdict |
|----------------|------------|----------|---------|-----------------------------------|---------------------------------|---------|
| Lora           | 902-928MHz | 30.49    | 1.119   | 0.056                             | 0.601                           | Pass    |
| WIFI           | 2.4GHz     | 28.94    | 0.77983 | 0.039                             | 1.0                             | Pass    |
| WCDMA          | II         | 29.00    | 0.79433 | 0.040                             | 1.0                             | Pass    |
|                | IV         | 29.00    | 0.79433 | 0.040                             | 1.0                             | Pass    |
|                | V          | 29.00    | 0.79433 | 0.040                             | 0.55                            | Pass    |
| LTE            | 2          | 29.00    | 0.79433 | 0.040                             | 1.0                             | Pass    |
|                | 4          | 29.00    | 0.79433 | 0.040                             | 1.0                             | Pass    |
|                | 5          | 29.00    | 0.79433 | 0.040                             | 0.55                            | Pass    |
|                | 12         | 29.00    | 0.79433 | 0.040                             | 0.47                            | Pass    |
|                | 13         | 29.00    | 0.79433 | 0.040                             | 0.52                            | Pass    |

| Operating Mode | Band       | PG (dBm) | PG (W)  | Calculation (W/m <sup>2</sup> ) | IC Limit (W/m <sup>2</sup> ) | Verdict |
|----------------|------------|----------|---------|---------------------------------|------------------------------|---------|
| Lora           | 902-928MHz | 30.49    | 1.119   | 0.557                           | 2.74                         | Pass    |
| WIFI           | 2.4GHz     | 28.94    | 0.77983 | 0.388                           | 5.35                         | Pass    |
| WCDMA          | II         | 28.00    | 0.63096 | 0.314                           | 4.48                         | Pass    |
|                | IV         | 28.00    | 0.63096 | 0.314                           | 4.24                         | Pass    |
|                | V          | 28.00    | 0.63096 | 0.314                           | 2.58                         | Pass    |
| LTE            | 2          | 28.50    | 0.70795 | 0.352                           | 4.48                         | Pass    |
|                | 4          | 28.50    | 0.70795 | 0.352                           | 4.24                         | Pass    |
|                | 5          | 28.50    | 0.70795 | 0.352                           | 2.58                         | Pass    |
|                | 12         | 28.50    | 0.70795 | 0.352                           | 2.30                         | Pass    |
|                | 13         | 28.50    | 0.70795 | 0.352                           | 2.47                         | Pass    |

B. Simultaneous Transmission operation mode (worst mode)

| FCC             |             |             |            |           |           |       |        |
|-----------------|-------------|-------------|------------|-----------|-----------|-------|--------|
| Operating Mode  | Lora Ratio1 | Lora Ratio2 | WIFI Ratio | LTE Ratio | Sum Ratio | Limit | Result |
| Lora+ WIFI+ LTE | 0.093       | /           | 0.039      | 0.085     | 0.217     | <1    | Pass   |
| Lora+ WIFI+ LTE | 0.093       | 0.093       | 0.039      | 0.085     | 0.310     | <1    | Pass   |
| IC              |             |             |            |           |           |       |        |
| Operating Mode  | Lora Ratio1 | Lora Ratio2 | WIFI Ratio | LTE Ratio | Sum Ratio | Limit | Result |
| Lora+ WIFI+ LTE | 0.203       | /           | 0.073      | 0.153     | 0.429     | <1    | Pass   |
| Lora+ WIFI+ LTE | 0.203       | 0.203       | 0.073      | 0.153     | 0.632     | <1    | Pass   |

Note:

1. The host has one or two identical Lora module.
2. The GSM/ UMTS /LTE modes cannot transmit simultaneous
3. The above RF output power refer to original FCC ID: 2AF6B-RAK634, 2AF6B-RAK5146, XMR201807EG95NA
4. . The above RF output power refer to original IC: 25908-RAK634, 25908-RAK5146, 10224A-2018EG95NA
5.  $R = 0.4m$