RF EXPOSURE

1. Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissive Exposure: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm^2]	Averaging Time [minute]
Limits for General Population / Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*(100)	30
1.34 ~ 30	824/f	2.19/f	*(180/f2)	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1 500	/	/	f/1 500	30
1 500 ~ 15 000	/	/	1	30

f=frequency in MHz, *= plane-wave equivalent power density

MPE (Maximum Permissive Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad \left(\Rightarrow R = \sqrt{PG/4\pi S} \right)$$

S = power density [mW/cm^2]
P = Power input to antenna [mW]
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 [cm]

2. RF Exposure Compliance Issue

The information should be included in the user's manual:

This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter. A minimum separation distance of 20 cm must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

MPE Calculations : LoRa

- Frequency Range :   923.3   MHz   ~   927.5   MHz

- Measured RF Maximum Output Power(Avg.) :   24.93   dBm

- Target Power & Tolerance   25.00   dBm   &   ±   1.00   dB

          (Maximum :   26.00   dBm   &   Minimum :   24.00   dBm   )

- Maximum Peak Antenna Gain :   5.83   dBi

- Maximum Output Power for the Calculation :   26.00   dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the
The MPE Calculations for this exposure is shown below.

- EIRP   =   P + G
 	
    =   26.00   dBm   +   5.83   dBi
 	
    =   31.83   dBm
 	
    =   1524.40   mW
	- NOTE
	
	P : Max tuneup Power (dBm)
	
	G : Maximum Peak Antenna Gain (dBi)

Power Density at the specific separation

- S   =   EIRP / (4 X R^2π)
 	
    =   1524.40   /   (4 X 20^2 X π)
 	
    =   **0.303 27**   mW/cm^2
	- NOTE
	
	S : Maximum Power Density (mW/cm^2)
	
	EIRP : Equivalent Isotropic Radiated Power (mW)
	
	R : Distance to the center of the radiation of the
	   antenna (20 cm)
	Limit : 0.6155 mW/cm^2

MPE Calculations : WCDMA Band II

- Frequency Range : <u>1852.4</u>   MHz ~ <u>1907.6</u>   MHz

- Measured RF Maximum Output Power(Avg.) :   <u>22.97</u>   dBm

- Target Power & Tolerance <u>23.00</u>   dBm & ± <u>1.00</u> dB

                         (Maximum : <u>24.00</u>   dBm & Minimum :   <u>22.00</u>   dBm)

- Maximum Peak Antenna Gain :   <u>2.93</u>   dBi

- **Maximum Output Power for the Calculation :   <u>24.00</u>   dBm**

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the
The MPE Calculations for this exposure is shown below.

- EIRP = P + G	- NOTE
= <u>24.00</u> dBm + <u>2.93</u> dBi	P : Max tuneup Power (dBm)
= <u>26.93</u> dBm	G : Maximum Peak Antenna Gain (dBi)
= <u>493.40</u> mW	

Power Density at the specific separation

- S = EIRP / (4 X R^2π)	- NOTE
= 493.40 / (4 X 20^2 X π)	S : Maximum Power Density (mW/cm^2)
= **0.098 159** mW/cm^2	EIRP : Equivalent Isotropic Radiated Power (mW)
	R : Distance to the center of the radiation of the
	antenna (<u>20</u> cm)
	Limit : 1.00 mW/cm^2

* This device uses a pre-certified module and LoRa.(pre-certified module FCC ID : N7NHL8548)

* This device uses only WCDMA among the wireless specifications of the pre-certified module.
  Therefore, we applied MPE as WCDMA Band ll and V.(worstcase : Band ll)

* WCDMA output power applied report values from pre-certified module.(Report No. : T140716W05-RP)

MPE Calculations : LoRa + WCDMA Band II

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the
The MPE Calculations for this exposure is shown below.

simultaneous MPE for Wi-Fi and Bluetooth

LoRa + WCDMA Band ll

- Total (%) =

  LoRa Result(mW/cm2) / Limit(mW/cm2)] +

  [WCDMA Result(mW/cm2) / Limit(mW/cm2)] * 100

  = [**0.303 270** / 0.62] +

    [**0.098 159** / 1.00] * 100

  = **40.143** %

- NOTE

  LoRa + WCDMA Band ll

  LoRa = 0.303 270 mW/cm2

  WCDMA Band ll = 0.098 159 mW/cm2

  Distance to the center of the radiation of the

  antenna (20 cm)

  Limit : ≤ 100 %

* This device uses a pre-certified module and LoRa.(pre-certified module FCC ID : N7NHL8548)

* This device uses only WCDMA among the wireless specifications of the pre-certified module.
  Therefore, we applied MPE as WCDMA Band ll and V.(worstcase : Band ll)

* WCDMA output power applied report values from pre-certified module.(Report No. : T140716W05-RP)