4 FCC §2.1091, FCC §15.247(i), FCC §15.407(h) & ISEDC RSS-102 – RF Exposure

4.1 Applicable Standards

According to §1.1307(b)(1), 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 level in excess of the Commission's guidelines.

According to KDB 447 498 Section (7.2), "simultaneous transmission of MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated 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.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* (100)	30
1.34-30	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

Where: f = frequency in MHz
* = Plane-wave equivalent power density

Before equipment certification is granted, the procedure of IC RSS-102 must be followed concerning the exposure of humans to RF field.

According to ISED RSS-102 Issue 6:

6.6 Field reference level exposure exemption limits

Field reference level (FRL) exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm (i.e. mobile devices), except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 1 W (adjusted for tune-up tolerance)
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $4.49/f^{0.5} W$ (adjusted for tune-up tolerance), where f is in MHz
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance)
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834} W$ (adjusted for tune-up tolerance), where f is in MHz
- at or above 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 5 W (adjusted for tune-up tolerance)

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the EIRP was derived.

4.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from 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

4.3 RF exposure evaluation for FCC

For 2.4 GHz Wi-Fi:

Worst Case: 2412 MHz

Maximum output power at antenna input terminal (dBm):	23.50
Maximum output power at antenna input terminal (mW):	223.87
Prediction distance (cm):	20
Prediction frequency (MHz):	2412
Maximum Directional Antenna Gain, typical (dBi):	2.6
Maximum Antenna Gain (numeric):	1.82
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.08
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 20cm is 0.08mW/cm^2. Limit is 1.0 mW/cm^2.

For 5 GHz Wi-Fi:

Worst Case: 5745 MHz

Maximum output power at antenna input terminal (dBm):	17.8
Maximum output power at antenna input terminal (mW):	60.26
Prediction distance (cm):	20
Prediction frequency (MHz):	5745
Maximum Directional Antenna Gain, typical (dBi):	4.8
Maximum Antenna Gain (numeric):	3.02
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.04
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 20cm is 0.04mW/cm^2. Limit is 1.0 mW/cm^2.

For BLE:

Worst Case: 2402 MHz

Maximum output power at antenna input terminal (dBm):	8.90
Maximum output power at antenna input terminal (mW):	7.76
Prediction distance (cm):	20
Prediction frequency (MHz):	2402
Maximum Directional Antenna Gain, typical (dBi):	1.9
Maximum Antenna Gain (numeric):	1.55
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.002
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 20cm is 0.002mW/cm^2. Limit is 1.0 mW/cm^2.

Note: The highest EIRP was referenced from test report: R2402274-247-02 issued by BACL.

For LTE:

Worst Case: LTE, Band 2, 1850 ~ 1910 MHz

Maximum output power at antenna input terminal (dBm):	25
Maximum output power at antenna input terminal (mW):	316.228
Prediction distance (cm):	20
Prediction frequency (MHz):	1892
Maximum Directional Antenna Gain, typical (dBi):	5
Maximum Antenna Gain (numeric):	3.162
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.199
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 20cm is 0.199 mW/cm^2. Limit is 1.0 mW/cm^2.

Note: The highest LTE EIRP was referenced from radio test report: 2211RSU065-E7 issued by MRT Technology (Suzhou) Co., Ltd.
Note: Antenna gain for the LTE module was provided by the customer <=5dBi. Referring to the antenna datasheet from www.quectel.com product OC: YE0001BA V.3 date: 2024-01-10.

Colocation Measurement:

This device has ability to simultaneously transmit LTE and Wi-Fi and BLE together.

Worst case colocation: LTE + 2.4 Wifi ratio+BLE. 0.199/1 +0.08/1 +0.002/1= 0.281 < 1
Worst case colocation: LTE + 5 Wifi ratio+BLE. 0.199/1 +0.04/1+0.002/1 = 0.241 < 1