

1. MAXIMUM PERMISSIBLE EXPOSURE (MPE)

1.1. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with § 2.1091
Radiofrequency radiation exposure evaluation: mobile devices of the FCC CFR
47 Rules, CFR 1.1310 (b) Radio frequency Radiation Exposure Requirement.

1.2. Special Accessories

Not available for this EUT intended for grant

1.3. Equipment Modifications

Not available for this EUT intended for grant.

1.4. Limitation

| Frequency Range (MHz) | 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/f ²) | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | / | / | F/1500 | 30 |
| 1500-15000 | / | / | 1.0 | 30 |

F = frequency in MHz

* = Plane-wave equipment power density

1.5. Exposure (MPE) Evaluation

The evaluation and calculation as deduces below presents only worst-case that produces highest value of the result:

$$S = PG/4\pi R^2$$

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

Worst case Max Power of each band

| Technology | Frequency (MHz) | Max Conducted Power (dBm) | Max Gain (dBi) | Duty Cycle | FCC Power Density @20cm (mW/cm ²) | FCC MPE Limit (mW/cm ²) |
|---|-----------------|---------------------------|----------------|------------|---|-------------------------------------|
| BT | 2441 | 10.70 | 1.53 | 100 | 0.00333 | 1.000 |
| WLAN Main Ant. Worst case | 2417 | 20.00 | 1.66 | 100 | 0.02917 | 1.000 |
| WLAN Aux Ant. Worst case | 2417 | 20.00 | 1.53 | 100 | 0.02831 | 1.000 |
| WCDMA Band IV (Worst case at Freq. Above 1500MHz) | 1852.4 | 24.50 | -2.14 | 100 | 0.03427 | 1.000 |
| WCDMA Band V (Worst case at Freq. Below 1500MHz) | 836.6 | 24.50 | -6.94 | 100 | 0.01135 | 0.558 |
| LTE B4 (Worst case at Freq. Above 1500MHz) | 2640.3 | 24.00 | -2.14 | 100 | 0.03055 | 1.000 |
| LTE B12 (Worst case at Freq. Below 1500MHz) | 699.7 | 24.00 | -4.87 | 100 | 0.01629 | 0.466 |

The predicted power density level of all scenarios are below the uncontrolled exposure limit.

1.6. Collocated MPE Analysis

The device may transmit simultaneously with other collocated radio transmitters within a host device, provided the following conditions are met:

- Each collocated radio transmitter has been certified by FCC for mobile application (that will be met since module will have its own FCC ID and host device will have its own FCC ID)
- At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times (host installation should taking care of that)

The output power and antenna gain in a collocated configuration must not exceed the limits and configurations stipulated in the following table 1. The power density calculations for the individual transmitters per wireless technology at an exposure minimum separation distance of 20cm.

Exclusion of test condition:

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 calculated or measured field strengths or power density, is ≤ 1.0 .

$$\Sigma MPE\ ratio1 + MPE\ ratio2 + MPE\ ratio3 \leq 1.0$$

The spreadsheet as FCC deduces, and releases is employed to conduct the measurement:

Worst case Max Power of each band

| Technology | Frequency (MHz) | Max Conducted Power (dBm) | Max Gain (dBi) | Duty Cycle | FCC Power Density @20cm (mW/cm ²) | FCC MPE Limit (mW/cm ²) |
|---|-----------------|---------------------------|----------------|------------|---|-------------------------------------|
| BT | 2441 | 10.70 | 1.53 | 100 | 0.00333 | 1.000 |
| WLAN Main Ant. Worst case | 2417 | 20.00 | 1.66 | 100 | 0.02917 | 1.000 |
| WLAN Aux Ant. Worst case | 2417 | 20.00 | 1.53 | 100 | 0.02831 | 1.000 |
| WCDMA Band IV (Worst case at Freq. Above 1500MHz) | 1852.4 | 24.50 | -2.14 | 100 | 0.03427 | 1.000 |
| WCDMA Band V (Worst case at Freq. Below 1500MHz) | 836.6 | 24.50 | -6.94 | 100 | 0.01135 | 0.558 |
| LTE B4 (Worst case at Freq. Above 1500MHz) | 2640.3 | 24.00 | -2.14 | 100 | 0.03055 | 1.000 |
| LTE B12 (Worst case at Freq. Below 1500MHz) | 699.7 | 24.00 | -4.87 | 100 | 0.01629 | 0.466 |

Evaluation is based on below combination that the device capable of transmitting simultaneously.

| Scenario | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| BT | V | V | V | V |
| WLAN Main Ant. Worst case | V | V | V | V |
| WLAN Aux Ant. Worst case | V | V | V | V |
| WCDMA Band IV (Worst case at Freq. Above 1500MHz) | V | | | |
| WCDMA Band V (Worst case at Freq. Below 1500MHz) | | V | | |
| LTE B4 (Worst case at Freq. Above 1500MHz) | | | V | |
| LTE B12 (Worst case at Freq. Below 1500MHz) | | | | V |

Scenario 1:
BT + WLAN Main Ant. Worst case + WLAN Aux Ant. Worst case + WCDMA Band IV (Worst case at Freq. Above 1500MHz)

| BT | FCC MPE limit | BT | WLAN Main Ant. Worst case | FCC MPE limit | WLAN Main Ant. Worst case | WLAN Aux Ant. Worst case | FCC MPE limit | WLAN Aux Ant. Worst case | WCDMA Band IV (Worst case at Freq. Above 1500MHz) | FCC MPE limit | WCDMA Band IV (Worst case at Freq. Above 1500MHz) | BT+ WLAN Main Ant. Worst case+ WLAN Aux Ant. Worst case+ WCDMA Band IV (Worst case at Freq. Above 1500MHz) | FCC Limit |
|-----------------------|-----------------------------------|-----------------------|---------------------------|-----------------------------------|---------------------------|--------------------------|-----------------------------------|--------------------------|---|-----------------------------------|---|--|-----------|
| (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | |
| 0.0033 | 1.0000 | 0.0033 | 0.0292 | 1.0000 | 0.0292 | 0.0283 | 1.0000 | 0.0283 | 0.0343 | 1.0000 | 0.0343 | 0.0951 | 1 |

Scenario 2:
BT + WLAN Main Ant. Worst case + WLAN Aux Ant. Worst case + WCDMA Band V (Worst case at Freq. Below 1500MHz)

| BT | FCC MPE limit | BT | WLAN Main Ant. Worst case | FCC MPE limit | WLAN Main Ant. Worst case | WLAN Aux Ant. Worst case | FCC MPE limit | WLAN Aux Ant. Worst case | WCDMA Band V (Worst case at Freq. Below 1500MHz) | FCC MPE limit | WCDMA Band V (Worst case at Freq. Below 1500MHz) | BT+ WLAN Main Ant. Worst case+ WLAN Aux Ant. Worst case+ WCDMA Band V (Worst case at Freq. Below 1500MHz) | FCC Limit |
|-----------------------|-----------------------------------|-----------------------|---------------------------|-----------------------------------|---------------------------|--------------------------|-----------------------------------|--------------------------|--|-----------------------------------|--|---|-----------|
| (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | |
| 0.0033 | 1.0000 | 0.0033 | 0.0292 | 1.0000 | 0.0292 | 0.0283 | 1.0000 | 0.0283 | 0.0113 | 0.5577 | 0.0203 | 0.0812 | 1 |

Scenario 3:
BT + WLAN Main Ant. Worst case + WLAN Aux Ant. Worst case + LTE B4 (Worst case at Freq. Above 1500MHz)

| BT | FCC MPE limit | BT | WLAN Main Ant. Worst case | FCC MPE limit | WLAN Main Ant. Worst case | WLAN Aux Ant. Worst case | FCC MPE limit | WLAN Aux Ant. Worst case | LTE B4 (Worst case at Freq. Above 1500MHz) | FCC MPE limit | LTE B4 (Worst case at Freq. Above 1500MHz) | BT+ WLAN Main Ant. Worst case+ WLAN Aux Ant. Worst case+ LTE B4 (Worst case at Freq. Above 1500MHz) | FCC Limit |
|-----------------------|-----------------------------------|-----------------------|---------------------------|-----------------------------------|---------------------------|--------------------------|-----------------------------------|--------------------------|--|-----------------------------------|--|---|-----------|
| (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | |
| 0.0033 | 1.0000 | 0.0033 | 0.0292 | 1.0000 | 0.0292 | 0.0283 | 1.0000 | 0.0283 | 0.0305 | 1.0000 | 0.0305 | 0.0914 | 1 |

Scenario 4:
BT + WLAN Main Ant. Worst case + WLAN Aux Ant. Worst case + LTE B12 (Worst case at Freq. Below 1500MHz)

| BT | FCC MPE limit | BT | WLAN Main Ant. Worst case | FCC MPE limit | WLAN Main Ant. Worst case | WLAN Aux Ant. Worst case | FCC MPE limit | WLAN Aux Ant. Worst case | LTE B12 (Worst case at Freq. Below 1500MHz) | FCC MPE limit | LTE B12 (Worst case at Freq. Below 1500MHz) | BT+ WLAN Main Ant. Worst case+ WLAN Aux Ant. Worst case+ LTE B12 (Worst case at Freq. Below 1500MHz) | FCC Limit |
|-----------------------|-----------------------------------|-----------------------|---------------------------|-----------------------------------|---------------------------|--------------------------|-----------------------------------|--------------------------|---|-----------------------------------|---|--|-----------|
| (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | (mW/cm ²) / MPE limit | (mW/cm ²) | (mW/cm ²) | |
| 0.0033 | 1.0000 | 0.0033 | 0.0292 | 1.0000 | 0.0292 | 0.0283 | 1.0000 | 0.0283 | 0.0163 | 0.4665 | 0.0349 | 0.0957 | 1 |