

MPE Report

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

Refer Standard:

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.

1. 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 modeled 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. 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.

2. Limits for General Population/Uncontrolled Exposure

(B) Limits for General Population/Uncontrolled Exposure

| Frequency Range (MHz) | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/cm ²) | Average Time E ² , H ² or S (minutes) |
|-----------------------|-----------------------------------|-----------------------------------|---|---|
| 0.3-1.34 | 614 | 1.63 | (100)* | 30 |
| 1.34-30 | 824/f | 2.19/f | (180/f)* | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | | | F/1500 | 30 |
| 1500-100000 | | | 1.0 | 30 |

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

3. 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

From the peak EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the maximum gain of the used antenna is 0dBi for both Lower power Bluetooth (BT 4.0) and Typical Bluetooth (BT 2.1+EDR), the RF power density can be obtained.

4. Conducted Power Results

Lower Power Bluetooth (BT 4.0)

| Mode | Frequency(MHz) | Perak Conducted Output Power (dBm) |
|---------|----------------|------------------------------------|
| GFSK-LE | 2402 | -0.502 |
| | 2440 | -0.581 |
| | 2480 | -0.365 |

Typical Bluetooth (BT 2.1+EDR)

| Mode | Frequency(MHz) | Perak Conducted Output Power (dBm) |
|-----------|----------------|------------------------------------|
| GFSK | 2402 | -1.438 |
| | 2441 | -2.089 |
| | 2480 | -2.812 |
| π/4 DQPSK | 2402 | -2.291 |
| | 2441 | -3.034 |
| | 2480 | -3.614 |

5. Manufacturing tolerance

Lower Power Bluetooth (BT 4.0)

| GFSK-LE (Peak) | | | |
|-----------------|------|------|------|
| Frequency (MHz) | 2402 | 2440 | 2480 |
| Target (dBm) | 0.0 | 0.0 | 0.0 |
| Tolerance ±(dB) | 1.0 | 1.0 | 1.0 |

Typical Bluetooth (BT 2.1+EDR)

| GFSK (Peak) | | | |
|------------------|------|------|------|
| Frequency (MHz) | 2402 | 2441 | 2480 |
| Target (dBm) | -1.0 | -2.0 | -2.0 |
| Tolerance ±(dB) | 1.0 | 1.0 | 1.0 |
| π/4 DQPSK (Peak) | | | |
| Frequency (MHz) | 2402 | 2441 | 2480 |
| Target (dBm) | -2.0 | -3.0 | -3.0 |
| Tolerance ±(dB) | 1.0 | 1.0 | 1.0 |

6. Measurement Results

6.1 Standalone MPE

Lower Power Bluetooth (BT 4.0)

| Mode | Peak Output Power Including power tolerance | | Antenna Gain (dBi) | Antenna Gain (numeric) | Duty Cycle | Power Density (mW/cm ²) | Limit of Power Density (mW/cm ²) | Pass /Fail |
|---------|---|--------|--------------------|------------------------|------------|-------------------------------------|--|------------|
| | (dBm) | (mW) | | | | | | |
| GFSK-LE | 1.0 | 1.2589 | 0.0 | 1.0 | 100% | 0.0003 | 1.0000 | Pass |

Typical Bluetooth (BT 2.1+EDR)

| Mode | Peak Output Power Including power tolerance | | Antenna Gain (dBi) | Antenna gain (numeric) | Duty Cycle | Power Density (mW/cm ²) | Limit of Power Density (mW/cm ²) | Pass /Fail |
|-----------|---|--------|--------------------|------------------------|------------|-------------------------------------|--|------------|
| | (dBm) | (mW) | | | | | | |
| GFSK | 0.0 | 1.0000 | 0.0 | 1.0 | 100% | 0.0002 | 1.0000 | Pass |
| π/4 DQPSK | -1.0 | 0.7943 | 0.0 | 1.0 | 100% | 0.0002 | 1.0000 | Pass |

6.2 Simultaneous Transmission

As Lower Power Bluetooth (BT 4.0) and Typical Bluetooth (BT 2.1+EDR) share difference antenna, we need consider transmit synchronization, more information as follows

| Modular | Antenna | Standalone TX | Synchronization TX |
|------------|-----------|---|---|
| BT 4.0 | Antenna 0 | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Antenna 0 and Antenna 1 <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| BT 2.1+EDR | Antenna 1 | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
 Σ of MPE ratios ≤ 1.0

$$\Sigma \text{ BT 4.0/BT 2.1+EDR MPE ratios} = \text{BT 4.0}_{\text{MPE ratios}} + \text{BT 2.1+EDR}_{\text{MPE ratios}} = 0.1 < 1.0$$

Note: The estimation distance is 20cm

7. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

-----THE END OF REPORT-----