

RF Exposure Evaluation

Limit

The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in 1.1310 & 2.1091

Table 1-Limits for Maximum Permissible Exposure (MPE)

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm ²) | Averaging time (minutes) |
|---|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| (A) Limits for Occupational/Controlled Exposures | | | | |
| 0.3–3.0 | 614 | 1.63 | *(100) | 6 |
| 3.0–30 | 1842/f | 4.89/f | *(900/f ²) | 6 |
| 30–300 | 61.4 | 0.163 | 1.0 | 6 |
| 300–1500 | - | - | f/300 | 6 |
| 1500–100,000 | - | - | 5 | 6 |
| (B) 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 |

Note: f = frequency in MHz

Evaluation Method

Transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where

P_d = power density in mW/cm², P_{out} = output power to antenna in mW, G = gain of antenna in linear scale;

$P_i = 3.1416$, R = distance between observation point and center of the radiator in cm

Conducted Power Results & Manufacturing tolerance

| Specification | Operating Mode | Conducted Peak Output Power (dBm) | Target (dBm) | Tolerance ±(dB) |
|---------------|----------------|-----------------------------------|--------------|-----------------|
| 2.4GWIFI | 802.11b | 15.72 | 15 | 1 |
| | 802.11g | 14.92 | 14 | 1 |
| | 802.11n(HT20) | 12.70 | 12 | 1 |
| | 802.11n(HT40) | 12.88 | 12 | 1 |
| BLE | GFKS | 7.00 | 6 | 1 |
| BT+EDR | GFKS | 5.84 | 5 | 1 |
| | π/4DQPSK | 6.64 | 6 | 1 |
| | 8DPSK | 7.17 | 7 | 1 |
| 5GWIFI | 802.11a | 10.99 | 10 | 1 |
| | 802.11n(HT20) | 10.25 | 10 | 1 |
| | 802.11n(HT40) | 10.42 | 10 | 1 |
| | 11ac(VHT20) | 10.20 | 10 | 1 |
| | 11ac(VHT40) | 10.48 | 10 | 1 |
| | 11ac(VHT80) | 7.86 | 7 | 1 |

Evaluation Results

| Spec. | Operating Mode | Antenna Distance (cm) | Conducted Output Power | | Gain of antenna in linear scale | Power Density (mW /cm ²) | Limit (mW /cm ²) | Result |
|----------|----------------|-----------------------|------------------------|-------|---------------------------------|--------------------------------------|------------------------------|--------|
| | | | dBm | mW | | | | |
| 2.4GWIFI | 802.11b | 20 | 16 | 39.81 | 1.00 | 0.008 | 1 | PASS |
| | 802.11g | 20 | 15 | 31.62 | 1.00 | 0.006 | 1 | PASS |
| | 802.11n(HT20) | 20 | 13 | 19.95 | 1.00 | 0.004 | 1 | PASS |
| | 802.11n(HT40) | 20 | 13 | 19.95 | 1.00 | 0.004 | 1 | PASS |
| BLE | GFKS | 20 | 7 | 5.01 | 1.00 | 0.0010 | 1 | PASS |
| BT+EDR | GFKS | 20 | 6.00 | 3.98 | 1.00 | 0.0008 | 1 | PASS |
| | π/4DQPSK | 20 | 7.00 | 5.01 | 1.00 | 0.0010 | 1 | PASS |
| | 8DPSK | 20 | 8.00 | 6.31 | 1.00 | 0.0013 | 1 | PASS |
| 5GWIFI | 802.11a | 20 | 11.00 | 12.59 | 1.00 | 0.003 | 1 | PASS |
| | 802.11n(HT20) | 20 | 11.00 | 12.59 | 1.00 | 0.003 | 1 | PASS |
| | 802.11n(HT40) | 20 | 11.00 | 12.59 | 1.00 | 0.003 | 1 | PASS |
| | 11ac(VHT20) | 20 | 11.00 | 12.59 | 1.00 | 0.003 | 1 | PASS |
| | 11ac(VHT40) | 20 | 11.00 | 12.59 | 1.00 | 0.003 | 1 | PASS |
| | 11ac(VHT80) | 20 | 8.00 | 6.31 | 1.00 | 0.001 | 1 | PASS |

Remark:

1. Output power including tune up tolerance;
2. The maximum 2.4G antenna gain is 0dBi
3. The maximum 5G antenna gain is 0dBi
4. The exposure safety distance is 20cm.

Simulation Transmission

EUT can only work in 2.4GWIFI+ Bluetooth mode or 5GWIFI+ Bluetooth mode

The formula of calculated the Simulation Transmission MPE is:

$$CPD1 /LPD1 + CPD2 /LPD2 + etc. < 1$$

CPD = Calculation Maximum Power Density

LPD = Limit of Power Density

| Mode | Calculate | Limit | Result |
|--------------------------|-----------|-------|--------|
| 2.4GWIFI+ Bluetooth mode | 0.0092 | 1 | PASS |
| 5GWIFI+ Bluetooth mode | 0.0038 | 1 | PASS |

Conclusion

The measurement results comply with the FCC Limit per 47 CFR 1.1310 & 2.1091 for the uncontrolled RF Exposure and MPE compliance per KDB 447498 v06.