# 14. FCC MAXIMUM PERMISSIBLE EXPOSURE (MPE)

## 14.1 Standard Applicable

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

This is a Mobile device, the MPE is required.

According to §1.1310 and §2.1093 RF exposure is calculated.

Limits for Maximum Permissive Exposure (MPE)

| 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

## 14.2 Maximum Permissible Exposure (MPE) Evaluation (Worst Case)

| 802.11g Main | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CH | Frequency (MHz) | Data Rate | Peak Output Power (dBm) | Peak Output Power (mW) | Limit | | | RESULT |
| 1 | 2412 | 6 | 22.69 | 185.78 | 1 Watt = | 30.00 | dBm | PASS |
| 6 | 2437 | 6 | **23.84** | **242.10** | 1 Watt = | 30.00 | dBm | PASS |
| 11 | 2462 | 6 | 22.48 | 177.01 | 1 Watt = | 30.00 | dBm | PASS |
| **802.11g Main** | | | | | | | | |
| CH | Frequency (MHz) | Data Rate | Avg. Output Power (dBm) | Avg. Output Power (mW) | Limit | | | RESULT |
| 1 | 2412 | 6 | 14.78 | 30.06 | 1 Watt = | 30.00 | dBm | PASS |
| 6 | 2437 | 6 | **16.48** | **44.46** | 1 Watt = | 30.00 | dBm | PASS |
| 11 | 2462 | 6 | 13.83 | 24.15 | 1 Watt = | 30.00 | dBm | PASS |

### MPE Prediction (802.11g 2412~2462)

Prediction 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

| | | |
|---|---|---|
| Max. output power including tune-up tolerancel: | 16.48 | (dBm) |
| Max. output power including tune-up tolerancel: | 44.463127 | (mW) |
| Duty cycle: | 100 | (%) |
| Maximum Pav : | 44.463127 | (mW) |
| Peak Antenna gain (Maximum): | 3.36 | (dBi) |
| Peak Antenna gain (linear): | 2.1677041 | (numeric) |
| Prediction distance: | 20 | (cm) |
| Prediction frequency: | 2437 | (MHz) |
| MPE limit for uncontrolled exposure at prediction | 1 | (mW/cm^2) |
| Power density at predication frequency at 20 (cm) | 0.019 | (mW/cm^2) |

**Measurement Result**

The predicted power density level at 20 cm is 0.019 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 2437MHz.

| 802.11n_HT20M MIMO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CH | Frequency (MHz) | Data Rate | Peak Output Power (dBm) | | Total Peak Output Power (dBm) | Total Peak Output Power (mW) | Limit | RESULT |
| | | | CH 0 | CH 1 | | | | |
| 1 | 2412 | MCS8 | 21.88 | 21.65 | **24.78** | 300.39 | 1 Watt = 29.73 dBm | PASS |
| 6 | 2437 | MCS8 | 21.65 | 21.53 | 24.60 | 288.45 | 1 Watt = 29.73 dBm | PASS |
| 11 | 2462 | MCS8 | 21.69 | 21.61 | 24.66 | 292.45 | 1 Watt = 29.73 dBm | PASS |

| 802.11n_HT20M MIMO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CH | Frequency (MHz) | Data Rate | Avg. Output Power (dBm) | | Avg. Output Power (dBm) | Avg. Output Power (mW) | Limit | RESULT |
| | | | CH 0 | CH 1 | | | | |
| 1 | 2412 | MCS8 | 13.30 | 13.60 | **16.46** | 44.29 | 1 Watt = 29.73 dBm | PASS |
| 6 | 2437 | MCS8 | 13.31 | 13.51 | 16.42 | 43.87 | 1 Watt = 29.73 dBm | PASS |
| 11 | 2462 | MCS8 | 13.27 | 13.57 | 16.43 | 43.98 | 1 Watt = 29.73 dBm | PASS |

## MPE Prediction (802.11n_HT20 2412~2462)

Prediction 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

**MIMO Gain: 3.36+3.01=6.37dBi**

| | | |
|---|---|---|
| Max. output power including tune-up tolerancel: | 16.46 | (dBm) |
| Max. output power including tune-up tolerancel: | 44.258837 | (mW) |
| Duty cycle: | 100 | (%) |
| Maximum Pav : | 44.258837 | (mW) |
| Peak Antenna gain (Maximum): | 6.37 | (dBi) |
| Peak Antenna gain (linear): | 4.3351088 | (numeric) |
| Prediction distance: | 20 | (cm) |
| Prediction frequency: | 2412 | (MHz) |
| MPE limit for uncontrolled exposure at prediction | 1 | (mW/cm2) |
| Power density at predication frequency at 20 (cm) | 0.038 | (mW/cm^2) |

**Measurement Result**

The predicted power density level at 20 cm is 0.038 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 2412MHz.

## Maximum Permissible Exposure (MPE) Evaluation (worst case)

| 802.11n_HT40M MIMO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CH | Frequency (MHz) | Data Rate | Peak Output Power (dBm) | | Total Peak Output Power (dBm) | Total Peak Output Power (mW) | Limit | RESULT |
| | | | CH 0 | CH 1 | | | | |
| 3 | 2422 | MCS8 | 19.91 | 14.73 | 21.06 | 127.67 | 1 Watt = 29.63 dBm | PASS |
| 6 | 2437 | MCS8 | 21.64 | 22.04 | 24.85 | 305.84 | 1 Watt = 29.63 dBm | PASS |
| 9 | 2452 | MCS8 | 21.73 | 22.08 | **24.92** | 310.37 | 1 Watt = 29.63 dBm | PASS |
| **802.11n_HT40M MIMO** | | | | | | | | |
| CH | Frequency (MHz) | Data Rate | Avg. Output Power (dBm) | | Avg. Output Power (dBm) | Avg. Output Power (mW) | Limit | RESULT |
| | | | CH 0 | CH 1 | | | | |
| 3 | 2422 | MCS8 | 10.62 | 6.65 | 12.08 | 16.16 | 1 Watt = 29.63 dBm | PASS |
| 6 | 2437 | MCS8 | 13.08 | 13.48 | 16.29 | 42.61 | 1 Watt = 29.63 dBm | PASS |
| 9 | 2452 | MCS8 | 13.16 | 13.61 | **16.40** | 43.66 | 1 Watt = 29.63 dBm | PASS |

### MPE Prediction (802.11n_HT40 2422~2452)

Prediction 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

**MIMO Gain: 3.36+3.01=6.37dBi**

| | | |
|---|---|---|
| Max. output power including tune-up tolerancel: | 16.40 | (dBm) |
| Max. output power including tune-up tolerancel: | 43.651583 | (mW) |
| Duty cycle: | 100 | (%) |
| Maximum Pav : | 43.651583 | (mW) |
| Peak Antenna gain (Maximum): | 6.37 | (dBi) |
| Peak Antenna gain (linear): | 4.3351088 | (numeric) |
| Prediction distance: | 20 | (cm) |
| Prediction frequency: | 2452 | (MHz) |
| MPE limit for uncontrolled exposure at prediction | 1 | (mW/cm^2) |
| Power density at predication frequency at 20 (cm) | 0.038 | (mW/cm^2) |

**Measurement Result**

The predicted power density level at 20 cm is 0.038 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 2452MHz.