# *Measurement of MPE*

## 1. Foreword

In adopt with the Human Exposure IEEE C95.1, and according to the FCC 1.1310. The *Maximum Permissible Exposure (MPE)* is obligated to measure in order to prove the safety of radiation harmfulness to the human body.

The *Gain* of the antenna used is measured in an a*nechoic chamber.* The *maximum total power to the antenna* is to be recorded. By adopting the ***Friis Transmission Formula*** and the *power gain of the antenna,* we can find the distance right away from the product, where the limit of the MPE is.

## 2. Limits for *Maximum Permissible Exposure (MPE)*

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Filed Strength (H) (A/m) | Power Density (S) (mW/cm2) | Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes) |
|---|---|---|---|---|
| **(A) Limits for Occupational/Controlled Exposure** | | | | |
| 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 |

**EUT Specification**

| | |
|---|---|
| **EUT** | 802.11a/b/g/n access point |
| **Frequency band (Operating)** | ☐ WLAN: 2.412GHz ~ 2.462GHz<br>☒ WLAN: 5.15GHz ~ 5.25GHz<br>☐ WLAN: 5.725GHz ~ 5.850GHz<br>☐ Bluetooth: 2.402 GHz ~ 2.482 GHz<br>☐ Others: _____ |
| **Device category** | ☐ Portable (<20cm separation)<br>☒ Mobile (>20cm separation)<br>☐ Others: _____ |
| **Exposure classification** | General Population/Uncontrolled exposure *(S=1mW/cm$^2$)* |
| **Antenna diversity** | ☐ Single antenna<br>☒ Multiple antennas<br>☐ Tx diversity<br>☐ Rx diversity<br>☒ Tx/Rx diversity |
| **Max. output power** | IEEE 802.11a mode: 10.34 dBm (10.81mW)<br>draft 802.11n Standard-20 MHz Channel mode: 16.33 dBm (42.95mW)<br>draft 802.11n Wide-40 MHz Channel mode: 16.60 dBm (45.70mW) |
| **Antenna gain (Max)** | 2 dBi (Numeric gain: 1.58)<br>TOTAL ANTENNA GAIN=6.77dBi(Numeric gain: 6.77) |
| **Evaluation applied** | ☒ MPE Evaluation<br>☐ SAR Evaluation*<br>☐ N/A |

***Remark:***

1. *The maximum output power is*16.60 dBm (45.70mW) *at 5230MHz (with 6.77 numeric antenna gain.)*
2. *For mobile or fixed location transmitters, no SAR consideration applied. The maximum power density is 1.0 mW/cm$^2$ even if the calculation indicates that the power density would be larger.*

**TEST RESULTS**

***No non-compliance noted.***

**Calculation**

Given $E = \frac{\sqrt{30 \times P \times G}}{d}$ & $S = \frac{E^2}{3770}$

*Where E = Field strength in Volts / meter*

*P = Power in Watts*

*G = Numeric antenna gain*

*d = Distance in meters*

*S = Power density in milliwatts / square centimeter*

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$S = \frac{30 \times P \times G}{3770 d^2}$$

Changing to units of mW and cm, using:

*P (mW) = P (W) / 1000 and*

*d (cm) = d(m) / 100*

Yields

$$S = \frac{30 \times (P/1000) \times G}{3770 \times (d/100)^2} = 0.0796 \times \frac{P \times G}{d^2}$$ ***Equation 1***

*Where d = Distance in cm*

*P = Power in mW*

*G = Numeric antenna gain*

*S = Power density in mW / cm$^2$*

**Maximum Permissible Exposure**

EUT output power = 45.71mW
Numeric Antenna gain = 6.77
Substituting the MPE safe distance using d = 20 cm into Equation 1:

Yields

$$S = 0.000199 \times P \times G$$

*Where P = Power in mW*

*G = Numeric antenna gain*

*S = Power density in mW / cm$^2$*

**IEEE 802.11a:**

EUT output power = 10.81mW

Numeric Antenna gain = 6.77

→ *Power density = 0.0102 mW / cm$^2$*

**draft 802.11an Standard-20 MHz Channel mode / Chain 0+ Chain 1 +Chain 2**

EUT output power = 42.95mW

Numeric Antenna gain = 6.77

→ *Power density = 0.0406mW / cm$^2$*

**draft 802.11an Wide-40 MHz Channel mode / Chain 0+ Chain 1 +Chain 2**

EUT output power =45.71mW

Numeric Antenna gain = 6.77

→ *Power density = 0.0432 mW / cm$^2$*

(For mobile or fixed location transmitters, the maximum power density is 1.0 mW/cm$^2$ even if the calculation indicates that the power density would be larger.)