

# 1 Human Exposure Assessment

## 1.1 Maximum Permissible Exposure

### 1.1.1 Limit of Maximum Permissible Exposure

| Limits for Occupational / Controlled Exposure                       |                                   |                                   |                                          |                                                                  |
|---------------------------------------------------------------------|-----------------------------------|-----------------------------------|------------------------------------------|------------------------------------------------------------------|
| Frequency Range (MHz)                                               | Electric Field Strength (E) (V/m) | Magnetic Field Strength (H) (A/m) | Power Density (S) (mW/ cm <sup>2</sup> ) | Averaging Time  E  <sup>2</sup> , H  <sup>2</sup> or S (minutes) |
| 0.3-3.0                                                             | 614                               | 1.63                              | (100)*                                   | 6                                                                |
| 3.0-30                                                              | 1842 / f                          | 4.89 / f                          | (900 / f)*                               | 6                                                                |
| 30-300                                                              | 61.4                              | 0.163                             | 1.0                                      | 6                                                                |
| 300-1500                                                            | -                                 | -                                 | F/300                                    | 6                                                                |
| 1500-100,000                                                        | -                                 | -                                 | 5                                        | 6                                                                |
| 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 <sup>2</sup> ) | Averaging Time  E  <sup>2</sup> , H  <sup>2</sup> 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                                                               |
| 1500-100,000                                                        | -                                 | -                                 | 1.0                                      | 30                                                               |
| Note 1: f = frequency in MHz ; *Plane-wave equivalent power density |                                   |                                   |                                          |                                                                  |
| Note 2: For the applicable limit, see FCC 1.1310                    |                                   |                                   |                                          |                                                                  |

| <b>RF Field Strength Limits for Controlled Use Devices (Controlled Environment)</b>               |                                 |                                                 |                                        |                                 |
|---------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------------------|----------------------------------------|---------------------------------|
| <b>Frequency Range (MHz)</b>                                                                      | <b>Electric Field (V/m rms)</b> | <b>Magnetic Field (A/m rms)</b>                 | <b>Power Density (W/m<sup>2</sup>)</b> | <b>Averaging Time (minutes)</b> |
| 0.003-1                                                                                           | 600                             | 4.9                                             | -                                      | 6                               |
| 1-10                                                                                              | 600/ <i>f</i>                   | 4.9/ <i>f</i>                                   | -                                      | 6                               |
| 10-30                                                                                             | 60                              | 4.9/ <i>f</i>                                   | -                                      | 6                               |
| 30-300                                                                                            | 60                              | 0.163                                           | 10*                                    | 6                               |
| 300-1500                                                                                          | 3.54 <i>f</i> <sup>0.5</sup>    | 0.0094 <i>f</i> <sup>0.5</sup>                  | <i>f</i> /30                           | 6                               |
| 1500-15000                                                                                        | 137                             | 0.364                                           | 50                                     | 6                               |
| 15000-150000                                                                                      | 137                             | 0.364                                           | 50                                     | 616000/ <i>f</i> <sup>1.2</sup> |
| 150000-300000                                                                                     | 0.354 <i>f</i> <sup>0.5</sup>   | 9.4 × 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup>  | 3.33 × 10 <sup>-4</sup> <i>f</i>       | 616000/ <i>f</i> <sup>1.2</sup> |
| <b>RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)</b> |                                 |                                                 |                                        |                                 |
| <b>Frequency Range (MHz)</b>                                                                      | <b>Electric Field (V/m rms)</b> | <b>Magnetic Field (A/m rms)</b>                 | <b>Power Density (W/m<sup>2</sup>)</b> | <b>Averaging Time (minutes)</b> |
| 0.003-1                                                                                           | 280                             | 2.19                                            | -                                      | 6                               |
| 1-10                                                                                              | 280/ <i>f</i>                   | 2.19/ <i>f</i>                                  | -                                      | 6                               |
| 10-30                                                                                             | 28                              | 2.19/ <i>f</i>                                  | -                                      | 6                               |
| 30-300                                                                                            | 28                              | 0.073                                           | 2*                                     | 6                               |
| 300-1500                                                                                          | 1.585 <i>f</i> <sup>0.5</sup>   | 0.0042 <i>f</i> <sup>0.5</sup>                  | <i>f</i> /150                          | 6                               |
| 1500-15000                                                                                        | 61.4                            | 0.163                                           | 10                                     | 6                               |
| 15000-150000                                                                                      | 61.4                            | 0.163                                           | 10                                     | 616000/ <i>f</i> <sup>1.2</sup> |
| 150000-300000                                                                                     | 0.158 <i>f</i> <sup>0.5</sup>   | 4.21 × 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup> | 6.67 × 10 <sup>-5</sup> <i>f</i>       | 616000/ <i>f</i> <sup>1.2</sup> |
| Note 1: <i>f</i> is frequency in MHz.                                                             |                                 |                                                 |                                        |                                 |
| Note 2: For the applicable limit, see IC RSS-102                                                  |                                 |                                                 |                                        |                                 |

### 1.1.2 MPE Calculation Method

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d}$$

**E** = Electric field (V/m)

**G** = EUT Antenna numeric gain (numeric)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$

$$\text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

**P** = RF output power (W)

**d** = Separation distance between radiator and human body (m)

**1.1.3 Result of Maximum Permissible Exposure-(2.4G)**

| Transmitter Chains & Receiver Chains Information                                                                                                                                                                           |                                              |                                             |                                                   |                       |             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------------------------------|---------------------------------------------------|-----------------------|-------------|
| IEEE Std. 802.11 Protocol                                                                                                                                                                                                  | Number of Transmit Chains (N <sub>TX</sub> ) | Number of Receive Chains (N <sub>RX</sub> ) | Correlation Signals with Multiple N <sub>TX</sub> | RF Output Power (dBm) | Co-location |
| b                                                                                                                                                                                                                          | 3                                            | 3                                           | Uncorrelated                                      | 23.79                 | N/A         |
| g                                                                                                                                                                                                                          | 3                                            | 3                                           | Uncorrelated                                      | 25.24                 | N/A         |
| n (HT20)                                                                                                                                                                                                                   | 3                                            | 3                                           | Uncorrelated                                      | 25.42                 | N/A         |
| n (HT40)                                                                                                                                                                                                                   | 3                                            | 3                                           | Uncorrelated                                      | 19.57                 | N/A         |
| Note 1: Co-location, Co-location is generally defined as simultaneously transmitting (co-transmitting) antennas within 20 cm of each other. (i.e., EUT has simultaneously co-transmitting that operating 2.4GHz and 5GHz.) |                                              |                                             |                                                   |                       |             |
| Note 2: RF output power specifies that Maximum Conducted (Average) Output Power.                                                                                                                                           |                                              |                                             |                                                   |                       |             |

| Worst Maximum RF Output Power Result                     |                 |                                            |              |              |   |           |            |            |                              |
|----------------------------------------------------------|-----------------|--------------------------------------------|--------------|--------------|---|-----------|------------|------------|------------------------------|
| Exposure Environment                                     |                 | General Population / Uncontrolled Exposure |              |              |   |           |            |            |                              |
| Separation Distance (cm)                                 |                 | 20                                         |              |              |   |           |            |            |                              |
| Condition                                                |                 | RF Output Power (dBm)                      |              |              |   |           |            |            |                              |
| Modulation Mode                                          | N <sub>TX</sub> | Chain-Port 1                               | Chain-Port 2 | Chain-Port 3 | - | Sum Chain | Gain (dBi) | EIRP Power | PD (S) (mW/cm <sup>2</sup> ) |
| 11B-20M                                                  | 3               | 19.21                                      | 18.56        | 19.31        | - | 23.79     | 2          | 25.79      | 0.075                        |
| 11G-20M                                                  | 3               | 20.56                                      | 19.92        | 20.88        | - | 25.24     | 2          | 27.24      | 0.105                        |
| 11N2.4G-20M                                              | 3               | 20.77                                      | 20.11        | 21.02        | - | 25.42     | 2          | 27.42      | 0.110                        |
| 11N2.4G-40M                                              | 3               | 14.74                                      | 14.41        | 15.21        | - | 19.57     | 2          | 21.57      | 0.029                        |
| Maximum Permissible Exposure Limit (mW/cm <sup>2</sup> ) |                 |                                            |              |              |   |           |            |            | 1                            |
| Note 1: N <sub>TX</sub> = Number of Transmit Chains      |                 |                                            |              |              |   |           |            |            |                              |