

**- RF Exposure (Balance Flex Antenna)**

1-1. FCC Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissible Exposure: RF exposure is calculated.

| Frequency Range                                       | Electric Field Strength [V/m] | Magnetic Field Strength [A/m] | Power Density [mW/cm <sup>2</sup> ] | 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 <sup>2</sup> )              | 30                      |
| 30 ~ 300  | 27.5                          | 0.073                         | 0.2                                 | 30                      |
| 300 ~ 1 500   | /                             | /                             | f/1 500                             | 30                      |
| 1 500 ~ 15 000  | /                             | /                             | 1.0                                 | 30                      |

*f*=frequency in MHz, \* = plane-wave equivalent power density

**MPE (Maximum Permissible Exposure) Prediction**

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad (\Rightarrow R = \sqrt{PG/4\pi S})$$

S = power density [mW/cm<sup>2</sup>]

P = Power input to antenna [mW]

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 [cm]

## 1-2. IC Regulation

According to RSS-102 Issue 5

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than  $4.49/f^{0.5}$  W (adjusted for tune-up tolerance), where  $f$  is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than  $1.31 \times 10^{-2} f^{0.6834}$  W (adjusted for tune-up tolerance), where  $f$  is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

## 2. RF Exposure Compliance Issue

The information should be included in the user's manual:

This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter. A minimum separation distance of 20 cm must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

### 3-1. Calculation Result of RF Exposure (FCC)

#### WLAN (2.4 GHz)

- Tune up tolerance

| Mode              | Frequency [MHz] | Max tune up power [dBm] | Max tune up power [mW] | Ant Gain [dBi] | Ant Gain [Linear scale] | Power Density at 20 cm [mW/cm <sup>2</sup> ] | Limit [mW/cm <sup>2</sup> ] |
|-------------------|-----------------|-------------------------|------------------------|----------------|-------------------------|--|-----------------------------|
| 802.11b ANT 0     | 2 437           | 14.00                   | 25.12                  | 3.50           | 2.24                    | 0.011 19                                     | 1.000 00                    |
| 802.11g ANT 1     | 2 412           | 14.00                   | 25.12                  | 1.70           | 1.48                    | 0.007 39                                     | 1.000 00                    |
| 802.11n HT20 MIMO | 2 462           | 14.00                   | 25.12                  | 2.69           | 1.86                    | 0.009 29                                     | 1.000 00                    |

#### WLAN (5 GHz)

- Tune up tolerance

#### U-NII-1

| Mode               | Frequency [MHz] | Max tune up power [dBm] | Max tune up power [mW] | Ant Gain [dBi] | Ant Gain [Linear scale] | Power Density at 20 cm [mW/cm <sup>2</sup> ] | Limit [mW/cm <sup>2</sup> ] |
|--------------------|-----------------|-------------------------|------------------------|----------------|-------------------------|--|-----------------------------|
| 802.11a Ant 0      | 5 180           | 12.50                   | 17.78                  | 4.70           | 2.95                    | 0.010 44                                     | 1.000 00                    |
| 802.11n HT20 Ant 1 | 5 180           | 12.50                   | 17.78                  | 5.20           | 3.31                    | 0.011 71                                     | 1.000 00                    |
| 802.11n HT20 MIMO  | 5 240           | 12.50                   | 17.78                  | 4.96           | 3.13                    | 0.011 08                                     | 1.000 00                    |

#### U-NII-2A

| Mode               | Frequency [MHz] | Max tune up power [dBm] | Max tune up power [mW] | Ant Gain [dBi] | Ant Gain [Linear scale] | Power Density at 20 cm [mW/cm <sup>2</sup> ] | Limit [mW/cm <sup>2</sup> ] |
|--------------------|-----------------|-------------------------|------------------------|----------------|-------------------------|--|-----------------------------|
| 802.11n HT20 Ant 0 | 5 280           | 12.50                   | 17.78                  | 5.30           | 3.39                    | 0.011 99                                     | 1.000 00                    |
| 802.11a Ant 1      | 5 320           | 12.50                   | 17.78                  | 5.70           | 3.72                    | 0.013 14                                     | 1.000 00                    |
| 802.11n HT20 MIMO  | 5 320           | 12.50                   | 17.78                  | 5.50           | 3.55                    | 0.012 57                                     | 1.000 00                    |

U-NII-2C

| Mode              | Frequency [MHz] | Max tune up power [dBm] | Max tune up power [mW] | Ant Gain [dBi] | Ant Gain [Linear scale] | Power Density at 20 cm [mW/cm <sup>2</sup> ] | Limit [mW/cm <sup>2</sup> ] |
|-------------------|-----------------|-------------------------|------------------------|----------------|-------------------------|--|-----------------------------|
| 802.11a_ Ant 0    | 5 700           | 12.50                   | 17.78                  | 4.90           | 3.09                    | 0.010 93                                     | 1.000 00                    |
| 802.11a_ Ant 1    | 5 700           | 12.50                   | 17.78                  | 4.80           | 3.02                    | 0.010 68                                     | 1.000 00                    |
| 802.11n HT20 MIMO | 5 700           | 12.50                   | 17.78                  | 4.85           | 3.06                    | 0.010 81                                     | 1.000 00                    |

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| Mode                | Frequency [MHz] | Max tune up power [dBm] | Max tune up power [mW] | Ant Gain [dBi] | Ant Gain [Linear scale] | Power Density at 20 cm [mW/cm <sup>2</sup> ] | Limit [mW/cm <sup>2</sup> ] |
|---------------------|-----------------|-------------------------|------------------------|----------------|-------------------------|--|-----------------------------|
| 802.11n HT20_ Ant 0 | 5 785           | 12.50                   | 17.78                  | 4.80           | 3.02                    | 0.010 68                                     | 1.000 00                    |
| 802.11a_ Ant 1      | 5 825           | 12.50                   | 17.78                  | 3.50           | 2.24                    | 0.007 92                                     | 1.000 00                    |
| 802.11n HT20 MIMO   | 5 785           | 12.50                   | 17.78                  | 4.20           | 2.63                    | 0.009 30                                     | 1.000 00                    |

### 3-2. Calculation Result of RF Exposure (IC)

WLAN (2.4 GHz)

- Tune up tolerance

| Mode              | Frequency [MHz] | Max tune up power [dBm] | Ant Gain [dBi] | E.I.R.P [dBm] | E.I.R.P [mW/] | Limit [mW/] |
|-------------------|-----------------|-------------------------|----------------|---------------|---------------|-------------|
| 802.11b_ ANT 0    | 2 437           | 14.00                   | 3.50           | 17.50         | 56.23         | 2 703.01    |
| 802.11g_ ANT 1    | 2 412           | 14.00                   | 1.70           | 15.70         | 37.15         | 2 684.03    |
| 802.11n HT20 MIMO | 2 462           | 14.00                   | 2.69           | 16.69         | 46.69         | 2 721.93    |

WLAN (5 GHz)

- Tune up tolerance

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| Mode              | Frequency [MHz] | Max tune up power [dBm] | Ant Gain [dBi] | E.I.R.P [dBm] | E.I.R.P [mW/] | Limit [mW/] |
|-------------------|-----------------|-------------------------|----------------|---------------|---------------|-------------|
| 802.11a_ Ant 0    | 5 180           | 12.50                   | 4.70           | 17.20         | 52.48         | 4 525.27    |
| 802.11a_ Ant 1    | 5 180           | 12.50                   | 5.20           | 17.70         | 58.88         | 4 525.27    |
| 802.11n HT20 MIMO | 5 240           | 12.50                   | 4.96           | 17.46         | 55.68         | 4 561.02    |

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| Mode               | Frequency [MHz] | Max tune up power [dBm] | Ant Gain [dBi] | E.I.R.P [dBm] | E.I.R.P [mW/] | Limit [mW/] |
|--------------------|-----------------|-------------------------|----------------|---------------|---------------|-------------|
| 802.11n HT20 Ant 0 | 5 280           | 12.50                   | 5.30           | 17.80         | 60.26         | 4 584.79    |
| 802.11a_ Ant 1     | 5 320           | 12.50                   | 5.70           | 18.20         | 66.07         | 4 608.50    |
| 802.11n HT20 MIMO  | 5 320           | 12.50                   | 5.50           | 18.00         | 63.16         | 4 608.50    |

U-NII-2C

| Mode              | Frequency [MHz] | Max tune up power [dBm] | Ant Gain [dBi] | E.I.R.P [dBm] | E.I.R.P [mW/] | Limit [mW/] |
|-------------------|-----------------|-------------------------|----------------|---------------|---------------|-------------|
| 802.11a _ Ant 0   | 5 700           | 12.50                   | 4.90           | 17.40         | 54.95         | 4 830.99    |
| 802.11a _ Ant 1   | 5 700           | 12.50                   | 4.80           | 17.30         | 53.70         | 4 830.99    |
| 802.11n HT20 MIMO | 5 700           | 12.50                   | 4.85           | 17.35         | 54.33         | 4 830.99    |

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| Mode               | Frequency [MHz] | Max tune up power [dBm] | Ant Gain [dBi] | E.I.R.P [dBm] | E.I.R.P [mW/] | Limit [mW/] |
|--------------------|-----------------|-------------------------|----------------|---------------|---------------|-------------|
| 802.11n HT20 Ant 0 | 5 785           | 12.50                   | 4.80           | 17.30         | 53.70         | 4 880.11    |
| 802.11a _ Ant 1    | 5 825           | 12.50                   | 3.50           | 16.00         | 39.81         | 4 903.14    |
| 802.11n HT20 MIMO  | 5 785           | 12.50                   | 4.20           | 16.70         | 46.76         | 4 880.11    |

Note.

- The power density Pd (5th column) at a distance of 20 cm calculated from the friis transmission formula is far below the limit of 1 mW/cm<sup>2</sup>.
- Unequal antenna gains, with equal transmit powers. For antenna gains given by G1, G2, ..., GN dB i (i) If transmit signals are correlated, then  
Directional gain = 10 log[(10G 1 /20 + 10G 2 /20 + ... + 10G N /20)2/NANT] dB i [Note the "20"s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

Antenna gain

| Antenna \ Band | 2.4 GHz | 5 GHz U-NII-1 | 5 GHz U-NII-2A | 5 GHz U-NII-2C | 5 GHz U-NII-3 |
|----------------|---------|---------------|----------------|----------------|---------------|
| ANT 0          | 3.50    | 4.70          | 5.30           | 4.90           | 4.80          |
| ANT 1          | 1.70    | 5.20          | 5.70           | 4.80           | 3.50          |
| ANT 0 + ANT 1  | 2.69    | 4.96          | 5.50           | 4.85           | 4.20          |