

# RF EXPOSURE

## 1. 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	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]

## 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.

## SAR test exclusion considerations : 802.11b

- Frequency Range : 2 412 MHz ~ 2 462 MHz
- Measured RF Maximum Output Power (Avg.) : 13.70 dBm
- Target Power & Tolerance 13.50 dBm &  $\pm$  1.00 dB  
( Maximum : 14.50 dBm & Minimum : 12.50 dBm )
- Maximum Peak Antenna Gain : 3.00 dBi
- Maximum Output Power for the Calculation : 14.50 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>14.50</u> dBm + <u>3.00</u> dBi</p> <p>= <u>17.50</u> dBm</p> <p>= <u>56.23</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 56.23 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.011 187</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : 802.11g

- Frequency Range : 2 412 MHz ~ 2 462 MHz
- Measured RF Maximum Output Power (Avg.) : 11.39 dBm
- Target Power & Tolerance 11.50 dBm &  $\pm$  1.00 dB  
( Maximum : 12.50 dBm & Minimum : 10.50 dBm )
- Maximum Peak Antenna Gain : 3.00 dBi
- Maximum Output Power for the Calculation : 12.50 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

- EIRP = P + G  = <u>12.50</u> dBm + <u>3.00</u> dBi  = <u>15.50</u> dBm  = <u>35.48</u> mW	- NOTE  P : Max tuneup Power (dBm)  G : Maximum Peak Antenna Gain (dBi)
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### Power Density at the specific separation

- S = EIRP / (4 X R <sup>2</sup> π)  = 35.48 / ( 4 X 20 <sup>2</sup> X π )  = <u>0.007 059</u> mW/cm <sup>2</sup>	- NOTE  S : Maximum Power Density (mW/cm <sup>2</sup> )  EIRP : Equivalent Isotropic Radiated Power (mW)  R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )
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## SAR test exclusion considerations : 802.11n\_HT20(2.4GHz)

- Frequency Range : 2 412 MHz ~ 2 462 MHz
- Measured RF Maximum Output Power (Avg.) : 11.07 dBm
- Target Power & Tolerance 11.00 dBm &  $\pm$  1.00 dB  
( Maximum : 12.00 dBm & Minimum : 10.00 dBm )
- Maximum Peak Antenna Gain : 3.00 dBi
- Maximum Output Power for the Calculation : 12.00 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>12.00</u> dBm + <u>3.00</u> dBi</p> <p>= <u>15.00</u> dBm</p> <p>= <u>31.62</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 31.62 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.006 291</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : 802.11a

- Frequency Range : 5 180 MHz ~ 5 805 MHz
- Measured RF Maximum Output Power (Avg.) : 12.61 dBm
- Target Power & Tolerance 12.50 dBm &  $\pm$  1.00 dB  
( Maximum : 13.50 dBm & Minimum : 11.50 dBm )
- Maximum Peak Antenna Gain : 4.50 dBi
- Maximum Output Power for the Calculation : 13.50 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>13.50</u> dBm + <u>4.50</u> dBi</p> <p>= <u>18.00</u> dBm</p> <p>= <u>63.10</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 63.10 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.012 552</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : 802.11n\_HT20(5GHz)

- Frequency Range : 5 180 MHz ~ 5 805 MHz
- Measured RF Maximum Output Power (Avg.) : 12.30 dBm
- Target Power & Tolerance 12.00 dBm &  $\pm$  1.00 dB  
( Maximum : 13.00 dBm & Minimum : 11.00 dBm )
- Maximum Peak Antenna Gain : 4.50 dBi
- Maximum Output Power for the Calculation : 13.00 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>13.00</u> dBm + <u>4.50</u> dBi</p> <p>= <u>17.50</u> dBm</p> <p>= <u>56.23</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 56.23 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.011 187</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : 802.11n\_HT40(5GHz)

- Frequency Range : 5 190 MHz ~ 5 795 MHz
- Measured RF Maximum Output Power (Avg.) : 12.38 dBm
- Target Power & Tolerance 12.00 dBm &  $\pm$  1.00 dB  
( Maximum : 13.00 dBm & Minimum : 11.00 dBm )
- Maximum Peak Antenna Gain : 4.50 dBi
- Maximum Output Power for the Calculation : 13.00 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>13.00</u> dBm + <u>4.50</u> dBi</p> <p>= <u>17.50</u> dBm</p> <p>= <u>56.23</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 56.23 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.011 187</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : Bluetooth(GFSK)

- Frequency Range : 2 402 MHz ~ 2 480 MHz
- Measured RF Maximum Output Power (Avg.) : 7.49 dBm
- Target Power & Tolerance 7.00 dBm &  $\pm$  1.00 dB  
( Maximum : 8.00 dBm & Minimum : 6.00 dBm )
- Maximum Peak Antenna Gain : 3.00 dBi
- Maximum Output Power for the Calculation : 8.00 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>8.00</u> dBm + <u>3.00</u> dBi</p> <p>= <u>11.00</u> dBm</p> <p>= <u>12.59</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 12.59 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.002 505</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : Bluetooth( $\pi/4$ DQPSK)

- Frequency Range : 2 402 MHz ~ 2 480 MHz
- Measured RF Maximum Output Power (Avg.) : 2.65 dBm
- Target Power & Tolerance 2.50 dBm &  $\pm$  1.00 dB  
( Maximum : 3.50 dBm & Minimum : 1.50 dBm )
- Maximum Peak Antenna Gain : 3.00 dBi
- Maximum Output Power for the Calculation : 3.50 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>3.50</u> dBm + <u>3.00</u> dBi</p> <p>= <u>6.50</u> dBm</p> <p>= <u>4.47</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup><math>\pi</math>)</p> <p>= 4.47 / ( 4 X 20<sup>2</sup> X <math>\pi</math> )</p> <p>= <u>0.000 889</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : Bluetooth(8DPSK)

- Frequency Range : 2 402 MHz ~ 2 480 MHz
- Measured RF Maximum Output Power (Avg.) : 2.67 dBm
- Target Power & Tolerance 2.50 dBm &  $\pm$  1.00 dB  
( Maximum : 3.50 dBm & Minimum : 1.50 dBm )
- Maximum Peak Antenna Gain : 3.00 dBi
- Maximum Output Power for the Calculation : 3.50 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

- EIRP = P + G  = <u>3.50</u> dBm + <u>3.00</u> dBi  = <u>6.50</u> dBm  = <u>4.47</u> mW	- NOTE  P : Max tuneup Power (dBm)  G : Maximum Peak Antenna Gain (dBi)
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### Power Density at the specific separation

- S = EIRP / (4 X R <sup>2</sup> π)  = 4.47 / ( 4 X 20 <sup>2</sup> X π )  = <u>0.000 889</u> mW/cm <sup>2</sup>	- NOTE  S : Maximum Power Density (mW/cm <sup>2</sup> )  EIRP : Equivalent Isotropic Radiated Power (mW)  R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )
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## SAR test exclusion considerations : Bluetooth LE

- Frequency Range : 2 402 MHz ~ 2 480 MHz
- Measured RF Maximum Output Power (Avg.) : 1.29 dBm
- Target Power & Tolerance 1.00 dBm &  $\pm$  1.00 dB  
( Maximum : 2.00 dBm & Minimum : 0.00 dBm )
- Maximum Peak Antenna Gain : 3.00 dBi
- Maximum Output Power for the Calculation : 2.00 dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

<p>- EIRP = P + G</p> <p>= <u>2.00</u> dBm + <u>3.00</u> dBi</p> <p>= <u>5.00</u> dBm</p> <p>= <u>3.16</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 3.16 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.000 629</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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## SAR test exclusion considerations : WLAN+Bluetooth+LE

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the  
The SAR test exclusion considerations for this exposure is shown below.

WLAN802.11n\_HT20(2.4GHz) + Bluetooth GFSK + Bluetooth LE

<p>- EIRP = ( 31.62 + 12.59 + 3.16 ) mW</p> <p>= <u>47.37</u> mW</p>	<p>- NOTE</p> <p>WLAN802.11n_HT20(2.4GHz) + Bluetooth GFSK + Bluetooth LE</p> <p>WLAN802.11n_HT20(2.4GHz) = 31.62 mW</p> <p>Bluetooth GFSK = 12.59 mW</p> <p>Bluetooth LE = 3.16 mW</p>
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### Power Density at the specific separation

<p>- S = EIRP / ( 4 X R<sup>2</sup>π )</p> <p>= 47.37 / ( 4 X 20<sup>2</sup> X π )</p> <p>= <u>0.009 424</u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p>
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