

Calculation of power density

Peak power density in the far field of a radio frequency point source is calculated as follows:



Note

The following calculation is based on the ANSI IEEE C95.1-1991 method, as that provides a worst case analysis. Details of the assessment to EN50383:2002 can be provided, if required.

$$S = \frac{P.G}{4\pi d^2}$$

Where:

Is:

S	power density in W/m ²
P	maximum average transmit power capability of the radio, in W
G	total Tx gain as a factor, converted from dB
d	distance from point source, in m

Rearranging terms to solve for distance yields:

$$d = \sqrt{\frac{P.G}{4\pi.S}}$$

Calculated distances and power compliance margins

The calculated minimum separation distances, recommended distances and resulting margins for each frequency band and antenna combination is shown in [Table 86](#), [Table 87](#), [Table 88](#), [Table 90](#), [Table 91](#), [Table 92](#) and [Table 93](#). These are conservative distances that include compliance margins. At these and greater separation distances, the power density from the RF field is below generally accepted limits for the general population.

Explanation of terms used in [Table 86](#), [Table 87](#), [Table 88](#), [Table 90](#), [Table 91](#), [Table 92](#) and [Table 93](#):

- Tx burst – maximum average transmit power in burst (Watt)
- P – maximum average transmit power capability of the radio (Watt)
- G – total transmit gain as a factor, converted from dB
- S – power density (W/m²)
- d – minimum distance from point source (meters)
- R – recommended distances (meters)
- C – compliance factor

Table 86 Power compliance margins, 5.1 GHz, AP

Conn Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m ²)	d (m)	R (m)	C
PMP	5/10 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	5/10 MHz	Connectorized Sector Array, 16 dBi	0.032	39.8	10	0.10	0.3	89.8
PTP	5/10 MHz	Connectorized Patch Panel Array, 23 dBi	0.010	199.5	10	0.13	0.3	56.7
PTP	5/10 MHz	Connectorized Dish, 30 dBi	0.002	1000.0	10	0.13	0.3	56.7
PMP	20/40 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	20/40 MHz	Connectorized Sector Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PTP	20/40 MHz	Connectorized Patch Panel Array, 23 dBi	0.008	199.5	10	0.11	0.3	71.3
PTP	20/40 MHz	Connectorized Dish, 30 dBi	0.001	1000.0	10	0.10	0.2	39.9

Table 87 Power compliance margins, 5.2/5.4/5.8 GHz, AP

Antenna	P (W)	G	S (W/m ²)	d (m)	R (m)	C
Connectorized Sector, 15 dBi	0.199	31.6	10	0.22	.4	33.1

Table 88 Power compliance margins, 5.1 GHz, STA

Conn Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m ²)	d (m)	R (m)	C
PMP	5/10 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	5/10 MHz	Integrated Patch Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PMP	5/10 MHz	Connectorized Sector Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PTP	5/10 MHz	Integrated Patch Array, 16 dBi	0.100	39.8	10	0.18	0.4	50.5
PTP	5/10 MHz	Connectorized Patch Panel Array, 23 dBi	0.013	199.5	10	0.14	0.3	45.0
PTP	5/10 MHz	Connectorized Dish, 30 dBi	0.001	1000.0	10	0.09	0.2	50.2

PMP	20/40 MHz	Connectorized Omni, 3 dBi	0.063	2.0	10	0.03	0.1	99.8
PMP	20/40 MHz	Integrated Patch Array, 16 dBi	0.032	39.8	10	0.10	0.2	39.9
PMP	20/40 MHz	Connectorized Sector Array, 16 dBi	0.032	39.8	10	0.10	0.3	89.8
PTP	20/40 MHz	Integrated Patch Array, 16 dBi	0.032	39.8	10	0.10	0.2	39.9
PTP	20/40 MHz	Connectorized Patch Panel Array, 23 dBi	0.005	199.5	10	0.09	0.2	50.2
PTP	20/40 MHz	Connectorized Dish, 30 dBi	0.001	1000.0	10	0.09	0.2	50.2

**Caution**

For countries that follow FCC regulations, the combined conducted power must be reduced according to [Table 89](#) for the lower edge of the 5.1 GHz band in order to meet restricted band requirements.

Table 89 FCC conducted power (combined) for lower edge of 5.1 GHz

Channel Bandwidth	Antenna	Conducted Power (combined)
5/10 MHz	Connectorized Omni, 3 dBi	18 dBm
5/10 MHz	Integrated Patch Array, 16 dBi	7 dBm
5/10 MHz	Connectorized Sector Array, 16 dBi	7 dBm
5/10 MHz	Connectorized Patch Panel Array, 23 dBi	0 dBm
5/10 MHz	Connectorized Dish, 30 dBi	-7 dBm
20/40 MHz	Connectorized Omni, 3 dBi	15 dBm
20/40 MHz	Integrated Patch Array, 16 dBi	7 dBm
20/40 MHz	Connectorized Sector Array, 16 dBi	7 dBm
20/40 MHz	Connectorized Patch Panel Array, 23 dBi	2 dBm
20/40 MHz	Connectorized Dish, 30 dBi	-5 dBm

Table 90 Power compliance margins, 5.4 GHz, STA

Antenna	P (W)	G	S (W/m ²)	d (m)	R (m)	C
Integrated Patch Array, 13 dBi	0.020	20	10	0.06	0.2	126.2
Integrated Patch Array, 13 dBi with Reflector Dish, 6 dBi	0.020	79.4	10	0.11	0.3	71.3
Connectorized Patch Panel Array, 23 dBi	0.020	199.5	10	0.18	0.4	50.5
Connectorized Dish, 30 dBi	0.020	1000	10	0.40	1	62.9

Table 91 Power compliance margins, 5.8/5.9 GHz, STA

Antenna	P (W)	G	S (W/m ²)	d (m)	R (m)	C
Integrated Patch Array, 13 dBi	0.199	20	10	0.18	0.4	50.5
Integrated Patch Array, 13 dBi with Reflector Dish, 6 dBi	0.199	79.4	10	0.36	0.8	50.7
Connectorized Patch Panel Array, 23 dBi	0.199	199.5	10	0.56	1.2	45.4
Connectorized Dish, 30 dBi	0.199	1000	10	1.26	2	25.2

Table 92 Power compliance margins, 2.4 GHz, AP

Conn Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m ²)	d (m)	R (m)	C
PMP	20 MHz	Connectorized, 8 dBi Omni	0.631	6.3	10	0.18	0.4	50.5
PMP	40 MHz	Connectorized, 8 dBi Omni	0.631	6.3	10	0.18	0.4	50.5
PMP	20 MHz	Connectorized, 17 dBi Sector	0.079	50.1	10	0.18	0.4	50.5
PMP	40 MHz	Connectorized, 17 dBi Sector	0.032	50.1	10	0.11	0.3	71.3
PTP	20 MHz	Connectorized, 25 dBi Dish	0.003	316.2	10	0.08	0.2	63.2
PTP	40 MHz	Connectorized, 25 dBi Dish	0.003	316.2	10	0.08	0.2	63.2

Table 93 Power compliance margins, 2.4 GHz, STA

Conn Type	Channel Bandwidth	Antenna	P (W)	G	S (W/m ²)	d (m)	R (m)	C
PMP	20 MHz	Connectorized, 8 dBi Omni	0.631	6.3	10	0.18	0.4	50.5
PMP	20 MHz	Integrated, 12 dBi Patch	0.251	15.8	10	0.18	0.4	50.5
PMP	20 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.398	100.0	10	0.56	1.0	50.0
PMP	20 MHz	Connectorized, 17 dBi Sector	0.079	50.1	10	0.18	0.4	50.5
PMP	20 MHz	Connectorized, 19 dBi Panel	0.050	79.4	10	0.18	0.4	50.5
PMP	20 MHz	Connectorized, 25 dBi Dish	0.010	316.2	10	0.16	0.4	63.5
PMP	40 MHz	Connectorized, 8 dBi Omni	0.100	6.3	10	0.07	0.2	79.6
PMP	40 MHz	Integrated, 12 dBi Patch	0.050	15.8	10	0.08	0.2	63.2
PMP	40 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.050	100.0	10	0.20	0.4	40.1
PMP	40 MHz	Connectorized, 17 dBi Sector	0.025	50.1	10	0.10	0.2	39.9
PMP	40 MHz	Connectorized, 19 dBi Panel	0.020	79.4	10	0.11	0.3	71.3
PMP	40 MHz	Connectorized, 25 dBi Dish	0.006	316.2	10	0.13	0.3	56.7
PTP	20 MHz	Integrated, 12 dBi Patch	0.398	15.8	10	0.22	0.4	31.9
PTP	20 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.398	100.0	10	0.56	1.2	45.4

PTP	20 MHz	Connectorized, 17 dBi Sector	0.158	50.1	10	0.25	0.5	39.5
PTP	20 MHz	Connectorized, 19 dBi Panel	0.050	79.4	10	0.18	0.4	50.5
PTP	20 MHz	Connectorized, 25 dBi Dish	0.010	316.2	10	0.16	0.4	63.5
PTP	40 MHz	Integrated, 12 dBi Patch	0.050	15.8	10	0.08	0.2	63.2
PTP	40 MHz	Integrated 12 dBi Patch with 8 dBi Reflector Dish	0.050	100.0	10	0.20	0.4	40.1
PTP	40 MHz	Connectorized, 17 dBi Sector	0.025	50.1	10	0.10	0.2	39.9
PTP	40 MHz	Connectorized, 19 dBi Panel	0.020	79.4	10	0.11	0.3	71.3
PTP	40 MHz	Connectorized, 25 dBi Dish	0.006	316.2	10	0.13	0.3	56.7

**Note**

Gain of antenna in dBi = $10 \cdot \log(G)$.

The regulations require that the power used for the calculations is the maximum power in the transmit burst subject to allowance for source-based time-averaging.

At 2.4 GHz, 5.4 GHz and EU 5.8 GHz the products are generally limited to a fixed EIRP which can be achieved with the Integrated Antenna. The calculations above assume that the maximum EIRP allowed by the regulations is being transmitted.

At 5.1 GHz the maximum EIRP at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

**Note**

If there are no EIRP limits in the country of deployment, use the distance calculations for FCC 5.8 GHz for all frequency bands.