

10. RF EXPOSURE

10.1. LIMIT

§15.255 (f) Regardless of the power density levels permitted under this section, devices operating under the provisions of this section are subject to the radiofrequency radiation exposure requirements specified in §§1.1307(b), 2.1091 and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

§1.1310(e) The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm ²) | Averaging time (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 |
| 300-1,500 | | | f/300 | 6 |
| 1,500-100,000 | | | 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 |
| 300-1,500 | | | f/1500 | 30 |
| 1,500-100,000 | | | 1.0 | 30 |

f = frequency in MHz * = Plane-wave equivalent power density

10.2. EQUATIONS

POWER DENSITY

Power Density is given by:

$$S = \text{EIRP} / (4 * \text{Pi} * D^2)$$

where,

S = Power density in mW/cm²
EIRP = Equivalent Isotropic Radiated Power in mW
D = Separation distance in cm

DISTANCE

Minimum Separation Distance is given by:

$$D = \text{SQRT} (\text{EIRP} / (4 * \text{Pi} * S))$$

where,

D = minimum separation distance in cm
EIRP = Equivalent Isotropic Radiated Power in mW
S = Power density limit in mW/cm²

UNITS

Conversions between mW and W, and between cm and m, are made as necessary.

10.3. UPPER BOUND POWER DENSITY OF UNWANTED EMISSIONS

The upper Bound of the sum of the power density of fundamental plus unwanted emissions at a 5 cm separation distance complies with RF Exposure limits.

TECHNICAL INFORMATION IN ACCORDANCE WITH 15.255 (g) SHOWING BASIS OF UPPER BOUND RESULTS FOR UNWANTED EMISSIONS

| Worst-case possible Integrated Band Power, assuming unwanted emissions encompass the entire band and the power density at every frequency is equal to the spurious emissions average limit | | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------|----------------------|------------------|-----------------|-----------|----------------------------------|---------------------------------|
| Band | Start (MHz) | Stop (MHz) | Limit (dBuV/m at 3m) | Limit (dBm EIRP) | Limit (mW EIRP) | RBW (MHz) | Num Intervals (stop-start)/(RBW) | Integrated Band Power (mW EIRP) |
| 30 to 88 MHz | 30 | 88 | 40 | -55.2 | 3.01995E-06 | 0.1 | 580 | 0.002 |
| 88 to 216 MHz | 88 | 216 | 43.5 | -51.7 | 6.76083E-06 | 0.1 | 1280 | 0.009 |
| 216 to 960 MHz | 216 | 960 | 46 | -49.2 | 1.20226E-05 | 0.1 | 7440 | 0.089 |
| 960 to 1000 MHz | 960 | 1000 | 54 | -41.2 | 7.58578E-05 | 0.1 | 400 | 0.030 |
| 1 to 40 GHz | 1000 | 40000 | 55 | -40.2 | 9.54993E-05 | 1 | 39000 | 3.724 |
| 30 MHz to 40 GHz | | | | | | | | 3.855 |

| Integrated Band Power, equal to the sum of the power of all measured unwanted emissions within the band. Measurements are peak, thus will over-estimate the average level. | | | | | | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--|--|-----------------------------|------------------------|--|---------------------------------|
| Freq or Band (GHz) | EUT Channel | | | Actual Emissions (dBm EIRP) | Actual Power (mW EIRP) | | Integrated Band Power (mW EIRP) |

| | | | | | | | |
|---------------|-----|--|--|------|----------|--|----------|
| No Emissions | | | | None | 0.000000 | | |
| 40 to 200 GHz | All | | | | | | 0.000000 |

| Total Integrated Band Power, equal to the worst-case possible 30 MHz to 40 GHz band power plus the measured 40 to 200 GHz band power | | | | | | | |
|--------------------------------------------------------------------------------------------------------------------------------------|-------------|--|--|--|--|--|---------------------------------|
| Band | EUT Channel | | | | | | Integrated Band Power (mW EIRP) |
| 30 MHz to 200 GHz | All | | | | | | 3.855 |

10.4. RESULTS FOR FUNDAMENTAL PLUS UNWANTED EMISSIONS

From FCC §1.1310 Table 1 (B), the maximum value of $S = 1.0 \text{ mW/cm}^2$

| Frequency (GHz) | FCC Limit (mW/cm ²) | Fundamental EIRP (dBm) | Fundamental EIRP (W) | Unwanted EIRP (mW) | Total EIRP (W) | Separation Distance (m) |
|--------------------|---------------------------------------|------------------------------|----------------------------|--------------------------|----------------------|-------------------------------|
| 58.32 | 1.00 | 39.21 | 8.337 | 3.855 | 8.341 | 0.26 |
| 60.48 | 1.00 | 38.62 | 7.278 | 3.855 | 7.282 | 0.24 |
| 62.64 | 1.00 | 39.43 | 8.770 | 3.855 | 8.774 | 0.26 |

10.5. RESULTS FOR CO-LOCATED TRANSMITTERS

Two 60 GHz transmitters installed at a single location may have overlapping beams and these overlapping beams may subsequently overlap with the Co-located 2.4 GHz Bluetooth transmitter. None of the beams are correlated with each other, therefore the sum of the worst-case EIRP of each transmitter is used to calculate the minimum required separation distance.

Parameters for the following calculations are based on the worst-case results obtained from the UL test report 11618371-E3V2 for FCC ID: 2AK7S-FBC1701.

Reference KDB KDB 447498 D01 General RF Exposure Guidance v06.

| Bluetooth Average Power (dBm) | Bluetooth Antenna Gain (dBi) | Bluetooth EIRP (dBm) | Bluetooth EIRP (mW) |
|-------------------------------------|------------------------------------|----------------------------|---------------------------|
| 2.85 | 3.300 | 6.15 | 4.121 |

From FCC §1.1310 Table 1 (B), the maximum value of $S = 1.0 \text{ mW/cm}^2$

| FCC Limit (mW/cm ²) | Total EIRP for 60 GHz Tx 1 (W) | Total EIRP for 60 GHz Tx 2 (W) | EIRP for Bluetooth (mW) | Total EIRP (W) | Separation Distance (m) |
|---------------------------------------|--------------------------------------|--------------------------------------|-------------------------------|----------------------|-------------------------------|
| 1.00 | 8.774 | 8.774 | 4.121 | 17.552 | 0.37 |

10.6. CONCLUSION

The minimum separation distance is 37 cm.