Test 8: Maximum Permissible Exposure

Test Requirement: 47 CFR Part 1

Test Specification: 47 CFR Part 1, Section 1.1307

Test Procedure:

Maximum Permissible Exposure limits are as follows:

FCC 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^2)	Averaging Time $\|E^2\|$, $\|H^2\|$. or S (minutes)
0.3 – 3.0	614	1.63	(100)*	6
3.0 - 30	1824/f	4.89/f	($900/f^2$)*	6
30 - 300	61.4	0.163	1.0	6
300 – 1500	-	-	f/300	6
1500 – 100,000	-	-	5.0	6

* Plane-wave equivalent power density

FCC 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^2)	Averaging Time $\|E^2\|$, $\|H^2\|$. or S (minutes)
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 – 1500	-	-	f/1500	30
1500 – 100,000	-	-	1.0	30

*Plane-wave equivalent power density

Test Details: This device is considered to possibly be located in either environment. See calculation for assumptions.

Background: Per the following guidance from OET Bulletin 65 Supplement C required minimum spacings are provided to the professional installer.

Transmitter or Device Type[18]	Output[19]	Applicable Methods to Ensure Compliance[20]
Transmitters using indoor antennas that operate at 20 cm or more from nearby persons	>2.5 W at 915 MHz	If the MPE distance is greater than that required for normal operation of the device, operating instructions, warning instructions and/or warning labels may be used to ensure compliance by indicating the minimal separation distance to comply with MPE limits. If the antennas are professionally installed to ensure compliance, warning instructions and warning labels are not necessary.
	=< 2.5 W at 915 MHz or =< 4 W at 2450 MHz	Transmitters operating at 2.5 W EIRP (1.5 W ERP) or less at 915 MHz, or at 4 W EIRP (2.4 W ERP) or less at 2450 MHz, generally are not expected to exceed MPE limits when nearby persons are 20 cm or more from most antennas. Therefore, special instructions and warnings are normally not necessary to ensure compliance.

MPE Calculation with highest EIRP:

Assuming the highest gain antenna intended for use (9 dBi gain) and the device output must be restricted to 380 mW to comply with the Uncontrolled/General Exposure at a 20 cm distance. Further, it is shown that operating at maximum power with an antenna of 7.5 dBi or less gain, 20 cm spacing is sufficient to comply with the Uncontrolled/General Exposure Limit.

$S = EIRP / (4 * Pi * R^2)$,

Power Density = EIRP / (4 * Pi * R^2),
where EIRP = Output Power * Antenna Gain

Uncontrolled/General Exposure – Calculation #1
0.380 Watt, 9 dBi antenna, 20 cm spacing

Operating Frequency	902 MHz		
Output Power (Peak)	**0.380** Watts		
Antenna Gain	**9** dB	or (linear)	7.94 (unitless)
Separation Distance	**0.20** m	-or-	7.874 inches

Peak Power Density	5.975 W/m^2	- or -	0.5975 mW/cm^2
Exposure % (over 6 min timespan for uncontrolled)	100%		
Transmit Duty Cycle (Peak-to-Average Ratio)	100%		
Average Power Density	**6.005** W/m^2		**0.6005** mW/cm^2
Limit for **Uncontrolled** Exposure at Operating Frequency	**6.01333** W/m^2	- or -	**0.601333** mW/cm^2

Uncontrolled/General Exposure – Calculation #2
0.535 Watt, 7.5 dBi antenna, 20 cm spacing

Operating Frequency	902 MHz		
Output Power (Peak)	**0.535** Watts		
Antenna Gain	**7.5** dB	or (linear)	5.623413 (unitless)
Separation Distance	**0.2** m	-or-	7.874 inches

Peak Power Density	5.985 W/m^2	- or -	0.5985 mW/cm^2
Exposure % (over 6 min timespan for uncontrolled)	100%		
Transmit Duty Cycle (Peak-to-Average Ratio)	100%		
Average Power Density	**5.98526** W/m^2	- or -	**0.5985** mW/cm^2
Limit for **Uncontrolled** Exposure at Operating Frequency	**6.01333** W/m^2	- or -	**0.601333** mW/cm^2