EXPOSURE LIMITS FOR ELECTROMAGNETIC RADIATION

Referenced Documents	*"Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300GHz)" ICNIRP Guidelines. Health Pysics 74 (4); 1998*
	FCC Part 47 of CFR, 1 October 2004, paragraph 1.1307
	IEEE C95.1-2005 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz -Description Table 8 and Table 9
	EN 62311:2008

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$$d = \frac{2.D^2}{\lambda} \qquad P_d = \frac{t \,.\, x \,.\, \mathrm{P.G}}{4.\pi \,.\, \mathrm{R}^2} \qquad \Longrightarrow \qquad R = \sqrt{\frac{t \,.\, x \,.\, \mathrm{P} \,.\, \mathrm{G}}{4 \,.\pi \,.\, P_d}}$$

near/far field boundary	d	16.95	m	
Wavelength	λ	0.0174	m	
maximum dimension of the antenna	D	0.384	m	
Transmit Power	P	1.7	W	
Maximum Duty Cycle correction factor	x	1.00		x = 69% Maximum Duty Cycle (general 5km), 84% duty cycle (normal 8km), max duty cycle 94% (Fast 8km mode) ref. 8BT3(
Mean Tx Power (inc. duty cycle)		1.70	W	
Gain of Antenna	G	26	dBi	
Linear Gain of Antenna		398.1071706		
Exposure Limit		10	W/m^2	
		1	mW/cm^2	Taken from ICNIRP report. IEEE quote this as 10mW/cm^2 for Controlled Exposure
Power Density @ d (d=R)	P_d	0.0188	mW/cm^2	
Safety margin @d		77.3	dB	
Exposure Limit in near field		3.3333	W/m^2	
see note 1		0.3333	mW/cm^2	Note 1: Applies 300% uncertainty factor for calculations in near field
Safe Distance from Antenna	**R**	**4.02**	**m**	Worst case scenario - Unscanning beam, 3.5 minutes exposure.

t = time exposure correction factor (referenced to 3.5 minutes)

SAFE DISTANCE MATRIX			Safe Distance Matrix (m)				
			FCC (Part 47 of CFR, para 1.1307) & ICNIRP		IEEE C95.1-2005		
	Exposure Duration {e} (seconds)	$t_{\{e/210\}}$	Uncontrolled Exposure (1mW/cm^2)	Controlled Exposure (5mW/cm^2)	Uncontrolled Exposure (1mW/cm^2)	Controlled Exposure (10mW/cm^2)	
In Front of Antenna (26 dBi antenna gain)			1	5	1	10	
Scanned (Does not take into account 300% uncertainty factor in near field)	2	0.01	0.23	0.10	0.23	0.07	Typical walk-by exposure time
	10	0.05	0.51	0.23	0.51	0.16	
	30	0.15	0.89	0.40	0.89	0.28	
	60	0.29	1.26	0.56	1.26	0.40	
	120	0.59	1.78	0.80	1.78	0.56	
	180	0.88	2.18	0.98	2.18	0.69	
	204	1.00	2.32	1.04	2.32	0.73	
Unscanned (Does take into account 300% uncertainty factor in near field)	2	0.01	0.40	0.18	0.40	0.13	Typical walk-by exposure time
	10	0.05	0.89	0.40	0.89	0.28	
	30	0.15	1.54	0.69	1.54	0.49	
	60	0.29	2.18	0.98	2.18	0.69	
	120	0.59	3.08	1.38	3.08	0.98	
	180	0.88	3.78	1.69	3.78	1.19	
	204	1.00	**4.02**	**1.80**	**4.02**	**1.27**	Continuous exposure (i.e. Not time limited)
Behind Antenna (0dBi antenna gain assumed)			1.00	5.00	1.00	10.00	
Scanned (Does not take into account 300% uncertainty factor in near field)	2	0.01	0.01	0.01	0.01	0.00	Typical walk-by exposure time
	10	0.05	0.03	0.01	0.03	0.01	
	30	0.15	0.04	0.02	0.04	0.01	
	60	0.29	0.06	0.03	0.06	0.02	
	120	0.59	0.09	0.04	0.09	0.03	
	180	0.88	0.11	0.05	0.11	0.03	
	204	1.00	0.12	0.05	0.12	0.04	
Unscanned (Does take into account 300% uncertainty factor in near field)	2	0.01	0.02	0.01	0.02	0.01	Typical walk-by exposure time
	10	0.05	0.04	0.02	0.04	0.01	
	30	0.15	0.08	0.03	0.08	0.02	
	60	0.29	0.11	0.05	0.11	0.03	
	120	0.59	0.15	0.07	0.15	0.05	
	180	0.88	0.19	0.08	0.19	0.06	
	204	1.00	0.20	0.09	0.20	0.06	

	Assumptions
Scanned	Beam scanning across frequency range. Scanning is expected to average out any local maximum, therefore can lose the 300% uncertainty in near field
Unscanned	Use 300% uncertainty for near field measurement
Exposure Duration {***t***}	Any frequency above 10GHz has to use a mean power averaged over a 68/f$^{1.05}$ minute (3.5mins) period in the calculation. This expsoure duration is converted to a fraction of 3.5 mintues.
Uncontrolled Exposure	General public exposure
Controlled Exposure	Occupational exposure
WiFi	The WLAN transmitter and Antenna gain are not significant in this calculation (0.14W & 4dBi).