1. RF Exposure Limit

According to the FCC rule 1.1310 table 1B, the limit for the maximum permissible RF exposure for an uncontrolled environment is 1mW/cm².

The electric field generated for a 1mW/cm²exposure is calculated as follows:

$E = \sqrt{(30 * P * G)} / d$, and $S = E^2 / Z = E^2 / 377$, because 1mW/ cm² = 10W/m²

S = Power density in mW/cm², Z = Impedance of free space, 377Ω

E = Electric filed strength in Volts/m, G = Numeric antenna gain, and d = distance in meter

Combing equations and rearranging the terms to express the distance as a function of the remaining variable

$d = \sqrt{(30*P*G) / (3770 *S)}$

Changing to units of mW and cm, using P (mW) = P (W) / 1000, d (cm) = 100 * d (m)

$d = 0.282 * \sqrt{(P*G) / S}$

d = distance in cm, P = Power in mW, G = Numeric antenna gain, and S = Power density in mW/cm²

2. Calculated MPE Safe Distance

2.1 For 802.11b WLAN Mode

According to above equation, the following result was obtained.

Peak Output Power		Antenna Gain		Safe Distance	Power Density (mW/cm²)	FCC Limit
(dBm)	(mW)	Log	Linear	(cm)	@ 20cm Separation	(mW/cm²)
14.70	29.51	2.0	1.58	1.926	0.009 28	1

According to above table, safe separation distance, $D = 0.282 * \sqrt{29.51 * 1.58} = 1.926$ cm.

For getting power density at 20 cm separation in above table, following formula was used.

$S = P*G / (4\pi*R^2) = 29.51*1.58/(4*3.14*20^2) = 0.009\ 28$
S = Power Density,
P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),
G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

2.2 For 802.11g WLAN Mode

According to above equation, the following result was obtained.

Peak Output Power		Antenna Gain		Safe Distance	Power Density (mW/cm²)	FCC Limit
(dBm)	(mW)	Log	Linear	(cm)	@ 20cm Separation	(mW/cm²)
15.50	35.48	2.0	1.58	2.161	0.011 68	1

According to above table, safe separation distance, $D = 0.282 * \sqrt{37.15 * 1.58} = 2.111$ cm.

For getting power density at 20 cm separation in above table, following formula was used.

$S = P*G / (4\pi*R^2) = 37.15*1.58/(4*3.14*20^2) = 0.011\ 16$
S = Power Density,
P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),
G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

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2.3 For SPI ZIGBEE Mode

According to above equation, the following result was obtained.

Peak Output Power		Antenna Gain		Safe Distance	Power Density (mW/cm²)	FCC Limit
(dBm)	(mW)	Log	Linear	(cm)	@ 20cm Separation	(mW/cm²)
12.30	16.98	2.0	1.58	1.461	0.005 34	1

According to above table, safe separation distance, $D = 0.282 * \sqrt{16.98 * 1.58} = 1.461$ cm.

For getting power density at 20 cm separation in above table, following formula was used.

$S = P*G / (4\pi*R^2) = 16.98*1.58/(4*3.14*20^2) = 0.005\ 34$
S = Power Density,
P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),
G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

2.4 For UART ZIGBEE Mode

According to above equation, the following result was obtained.

Peak Output Power		Antenna Gain		Safe Distance	Power Density (mW/cm²)	FCC Limit
(dBm)	(mW)	Log	Linear	(cm)	@ 20cm Separation	(mW/cm²)
11.80	15.14	2.0	1.58	1.379	0.004 76	1

According to above table, safe separation distance, $D = 0.282 * \sqrt{15.14 * 1.58} = 1.379$ cm.

For getting power density at 20 cm separation in above table, following formula was used.

$S = P*G / (4\pi*R^2) = 15.14*1.58/(4*3.14*20^2) = 0.004\ 76$
S = Power Density,
P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),
G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna

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