MPE CALCULATION FOR MULTIPLE TX SOURCES

Silver Spring Networks AP 1.5 with Sierra Wireless radio modem module
FCC ID: OWS-NIC505
Contains FCC ID: N7NMC8781

The following relationships between power density (S), distance from antenna (d meters), transmitter field strength (E v/m), transmitter power (P, watts) and antenna gain (G, numeric) are used to determine MPE for each transmitter:

$E^2/3770 = S$, mW/cm^2
E, V/m = $(Pwatts*Ggain*30)^{-5}/d$, meters
MPE d,m = $((Pwatts*G*30)/3770*S))^{0.5}$
Pwatts*Ggain = $10^{(PdBm-30+GdBi)/10)}$
$S@dist2 = S@dist1*(dist1/dist2)^2$

The duty cycles of the different radios were obtained from exhibits submitted with FCC certification applications for the two products.

1. MPE for 824 MHz Sierra Wireless module operation:
Maximum output power: 31.9 dBm
Source based duty cycle: 50% = -3 dB
(Note: Power and duty cycle information obtained from original Sierra Wireless certification application)
Antenna gain : 3 dBi – 0.5 dB cable loss = 2.5 dBi effective antenna gain
Maximum eirp = 32 -3 +3 -0.5 = 31.5 dBm eirp
Maximum allowed RF exposure, general exposure limit, 824 MHz, from Table1 OET 65: 0.55 mW/cm^2
MPE : 14.3 cm
S at 20 cm: 0.28 mW/cm^2

2. MPE for 1850 MHz Sierra Wireless module operation:
Maximum output power: 28.8 dBm
Source based duty cycle: 100% = 0 dB
(Note: Power and duty cycle information obtained from original Sierra Wireless certification application)
Antenna gain : 5 dBi – 1 dB cable loss = 4 dBi effective antenna gain
Maximum eirp = 28.8 +5 -1 = 32.8 dBm eirp
Maximum allowed RF exposure, general exposure limit, 1850 MHz, from Table1 OET 65: 1.0 mW/cm^2
MPE : 12.3 cm
S at 20 cm: 0.38 mW/cm^2

3. MPE for 902 MHz Silver Spring Networks FHSS transmitter:
Maximum output power: 29.8 dBm
Source based duty cycle: 100% = 0 dB
(Note: Power and duty cycle information obtained from Silver Spring Networks certification application)
Antenna gain : 3 dBi
Maximum eirp = 29.8 +5 -1 = 32.8 dBm eirp
Maximum allowed RF exposure, general exposure limit, 902 MHz, from Table1 OET 65: 1.0 mW/cm^2
MPE : 16 cm
S at 20 cm: 0.38 mW/cm^2

Per OET 65, the allowed cumulative exposure limit at a given point from two transmitters operating at different frequencies is

$S_{f1}/S_{f1limit} + S_{f2}/S_{f2limit} < 1$, where

S_{f1} = power density at a given point for transmitter operating at F1 MHz

S_{f2} = power density at a given point for transmitter operating at F2 MHz
$S_{f1limit}$ = power density limit at frequency F1 (from Table 1 in Appendix A of OET 65)
$S_{f2limit}$ = power density limit at frequency F2 (from Table 1 in Appendix A of OET 65)
From calculations above, at 20 cm, and limits from Table 1

$S_{824\ MHz} = 0.28\ mW/cm^2$ $S_{824MHzlimit} = 0.55\ mW/cm^2$
$S_{902MHz} = 0.38\ mW/cm^2$ $S_{902MHzlimit} = 0.6\ mW/cm^2$
$S_{1850MHz} = 0.38\ mW/cm^2$ $S_{1850MHzlimit} = 1.0\ mW/cm^2$

Worst-case multiple transmitter operation are at either 824/902 MHz or 1850/902 MHz.

Frequency weighted combined exposure at 20cm, 824/902 MHz operation:
0.28/.55 + .38/.6 = .51 + .63 = 1.14 > 1 **Worst case**

Frequency weighted combined exposure at 20cm, 1850/902 MHz operation:
0.38/1 + .38/.6 = .38 + .63 = 1.01 > 1

Solving for separation distance that will result in frequency weighted combined exposure =1
From above

$S@dist2 = S@dist1*(dist1/dist2)^2$ dist1= 20cm, dist2 = distance at which combined exposure =1

$dist2 = 20cm * (1.14/1)^{0.5}$

= 21.4 cm MPE distance for simultaneous operation

Spread sheet used to calculate RFx

Silver Spring Networks										
FCC ID: OWS-NIC505										
902-928MHz FHSS radio with cell phone module						**Calculate mW/cm2 here. Enter frequency in MHz:**				
Module FCC ID: N7NMC8781		(824/930/1930 MHz)								
						Calculation of Limits from 1.1310 Table 1				
S1 for 824 MHz		0.55	maximum						Controlled	Uncontrolled
S2 for 902 MHz		0.60	maximum						Ave 6 min	Ave 30 min
S3 for 1930 MHz		1.00	maximum			F(MHz)	**Actual F, MHz**		Occ. mW/cm2	Gen. mW/cm2
						0.3-3	0.5		100.0	100.0
Max RF Power	TX Antenna	MPE distance	S, mW/cm2	S, mW/cm2	Comment	*3.0 - 30.0*	*5*		*180.0*	*36.0*
P, dBm	G, dBi	cm	at 20 cm dist	at 21.4 cm dist		**30.0-300**	**55**		1.0	0.2
						300-1500	*824*		*2.7*	*0.55*
29.0	2.50	14.3	0.28	0.25	824 MHz Duty Cycle = 50%	1500-100000	5555		5.0	1.0
29.8	3.0	16.0	0.38	0.33	902MHz Duty Cycle = 100%					
28.8	4.0	12.3	0.38	0.33	1850 MHz Duty Cycle=100%					
						Enter P(mW)	Equivalent dBm	**Enter dBm**	Equivalent Watts	
Total cell FHSS	**= S1/.55+ S2/.6**		114.2	100	Cell / FHSS total %					
Total FHSS PCs	**=S2/.6+S3/1.0**		101.3	86	FHSS/PCS total %					
Basis of Calculations:						*759*	28.80	*29.52*	895.4	
E^2/3770 = S, mW/cm2										
E, V/m = (Pwatts*Ggain*30)^.5/d, meters										
d = ((Pwatts*G*30)/3770*S))^0.5			Pwatts*Ggain = 10^(PdBm-30+GdBi)/10)							
S@dist2 = S@MPEdist(MPE/dist2)^2										
NOTE: For mobile or fixed location transmitters, minimum separation distance is for FCC compliance is 20 cm,										
even if calculations indicate MPE distance is less										