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RF Exposure

Reference: CFR 47 FCC Part 1.1310
RSS-102. Issue 5

Description: All 4 transmitters in the device have the possibility of transmitting simultaneously. The worst-case exposure for each transmitter was used to calculate the percentage of the allowable limit that each transmitter contributed. All of the percentages were then added together to verify that at the specified operating distance, they were below the allowable limit.

All measurements were peak or RMS power readings taken from test reports from accredited test labs. Antenna gains were taken from the manufacturer's specifications.

Limits: Maximum exposure limits from CFR 47, FCC Part 1.1310:

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

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RF Exposure

GSM model - FCC

Distance	40	cm

Transmitter	Frequency	Antenna Gain	Power	Power Density	Limit	% of limit	Highest	Total
	MHz	numerical	mW	mW/cm^2	mW/cm^2			
433	433.92	1	1.82	0.0000906	0.2893	0.03%	1	0.03%
WIFI	2462	4.466	46.90	0.0104227	1.0000	1.04%	1	1.04%
Satcom	1626.5	3.5	1479.00	0.2575886	1.0000	25.76%	1	25.76%
GSM	824.2	3.548	1819.00	0.3211491	0.5495	58.45%	1	58.45%
GSM	1850.2	3.548	955.00	0.1686077	1.0000	16.86%	0	0.00%
							TOTAL	**85.28%**

Power Conversion
-10 dBm = .1 mW
20 dBm = 100 mW
30 dBm = 1000 mW

PASS?	YES

Notes:

1. For 433 MHz radio, antenna gain was set to 1 because power was based on EIRP from field strength measurement

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RF Exposure

LTE model - FCC

Distance	40	cm

Transmitter	Frequency	Antenna Gain	Power	Power Density	Limit	% of limit	Highest	Total
	MHz	numerical	mW	mW/cm^2	mW/cm^2			
433	433.92	1	1.82	0.0000906	0.2893	0.03%	1	0.03%
WIFI	2462	4.466	46.90	0.0104227	1.0000	1.04%	1	1.04%
LTE	1717.5	3.548	177.00	0.0312498	1.0000	3.12%	1	3.12%
LTE	779.5	3.548	162.00	0.0286015	0.5197	5.50%	0	0.00%
Satcom	1626.5	3.5	1479.00	0.2575886	1.0000	25.76%	1	25.76%
							TOTAL	29.96%

Power Conversion
-10 dBm = .1 mW
20 dBm = 100 mW
30 dBm = 1000 mW

PASS?	YES

Notes:

1. For 433 MHz radio, antenna gain was set to 1 because power was based on EIRP from field strength measurement

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RF Exposure

Table 2 - From Table 4 of RSS-102 Issue 5

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

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RF Exposure

GSM Model - ISED

Occupational/Controlled	1
General Population/uncontrolled	0

Transmitter	Frequency	Antenna Gain	Power	Power Density	Limit at specified distance	% of limit	Highest	Total
	MHz	numerical	mW	mW/cm^2	mW/cm^2			
433	433	1	1.82	0.00	1.34	0.01%	1	0.01%
WiFi	2462	4.466	46.90	0.01	3.20	0.33%	1	0.33%
GSM	824	3.548	1819.00	0.32	1.85	17.33%	1	17.33%
GSM	1850	3.548	955.00	0.17	2.78	6.07%		
Satcom	1626.5	2.34	1479.00	0.17	2.60	6.62%	1	6.62%
							TOTAL	24.28%

Distance	40	cm	PASS?	YES

Notes:

1. For 433 MHz radio, antenna gain was set to 1 because power was based on EIRP from field strength measurement

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RF Exposure

LTE Model - ISED

Occupational/Controlled	1
General Population/uncontrolled	0

Transmitter	Frequency	Antenna Gain	Power	Power Density	Limit at specified distance	% of limit	Highest	Total
	MHz	numerical	mW	mW/cm^2	mW/cm^2			
1	433	1	1.82	0.00	1.34	0.01%	1	0.01%
2	2462	4.466	46.90	0.01	3.20	0.33%	1	0.33%
3	1717.5	3.548	177.00	0.03	2.68	1.17%		
3	779.5	3.548	162.00	0.03	1.80	1.59%	1	1.59%
4	1626.5	3.5	1479.00	0.26	2.60	9.89%	1	9.89%
							TOTAL	11.81%

Distance	40	cm

PASS?	YES

Notes:

1. For 433 MHz radio, antenna gain was set to 1 because power was based on EIRP from field strength measurement

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RF Exposure

The limit was converted from W/cm^2 to mW/m^2 by dividing by 10
(W→mW = .001) × (/cm^2→/m^2 = 100) = 0.1 = /10

The power density is calculated as shown below:

S = (P x G)/(4 x π x d^2) – used to calculate exposure at 20 cm

d = √(S/(P x G) x 4 X π) – used to calculate minimum distance to meet limits

1 mW/cm^2 = 10 W/m^2

S= power density
P = transmitter conducted power (in mW)
G = antenna numeric gain
D = distance to radiation center

See the antenna datasheets and specifications for antenna gain

Notes: The minimum separation distance was defined as the closest point from the transmitting antenna to any part of the body or extremity of a user or bystander.

The minimum separation distance is listed as 40cm the FCC and IC.