EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER

I. GENERAL INFORMATION

Requirement:	FCC, Industry Canada
Test Requirements:	FCC Part 15, RSS-Gen, RSS-210
Applicant:	Sentient Energy Inc. 880 Mitten Rd Suite 105 Burlingame CA 94010
FCC ID:	**Z2E-MM2SSN1**
IC:	**9908A-MM2SSN1**
Model No.:	MM2
Add Antenna:	4 dBi Inverted F

II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Sentient Energy model MM2 is a radio module for electric power meter communications use. The board incorporates a 900 MHz frequency hopping radio.

The product has been certified with an internal custom sheet metal antenna. A new antenna has been developed for use with the module installed in a Sentient Energy power management communication device.

III. TEST DATES AND TEST LOCATION

Testing was performed on November 7 and November 23, 2011. Radiated tests were performed at:

BACL – Bay Area Compliance Labs Corp.
1274 Anvilwood Ave.
Sunnyvale, CA 94089

Antenna port power measurements were performed at Sentient Energy.

T.N. Cokenias
EMC Consultant/Agent for Sentient Energy Inc.

23 November 2011

15.203 Antenna connector requirement

The EUT will be used with the following antenna.

Antenna description	Mfr.	Model No.	Gain
Inverted "F"	Sentient	MM2	4 dBi at 915 MHz

TEST PROCEDURES

All tests were performed in accordance with the applicable procedures called out in the following documents, unless otherwise noted:

FCC 47CFR15

RSS-210 Issue 8: Low power license exempt radio frequency devices (Dec 2010)
RSS-212: Test Facilities and Test Methods for Radio Equipment

ANSI C63.4 – 2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

Test were performed at three frequencies:

900 MHz FHSS

Channel 0 (LOW) – 902.3 MHz
Channel 43 (MID) -915.2 MHz
Channel 82 (HIFH) – 926.9 MHz

Test Equipment

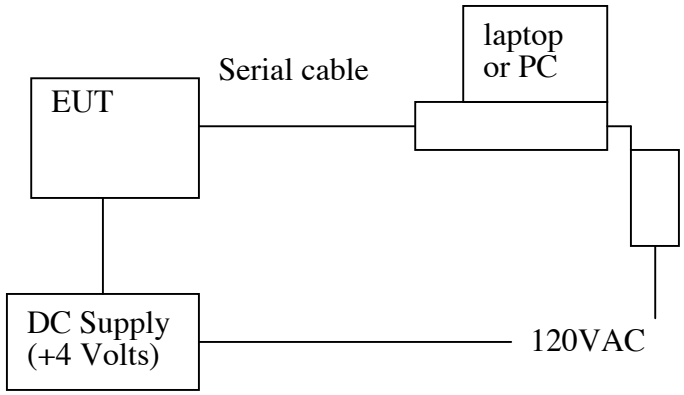
BACL

DESC.	Model	Freq. Range	Mfr	Serial No.	Last Cal	Cal Due
Antenna, Biconi-Log	JB3	30 - 3000MHz	Sunol Sciences	A020106-2	2011-08-10	2012-08-10
Amplifier	ZVA-183-S	1-18 GHz	Mini-Circuits	570400946	2011-05-09	2012-05-09
Amplifier, Pre	8447D	0.1-1300 MHz	HP	2944A06639	2011-06-09	2012-06-09
Antenna, Horn	3115	1-18 GHz	EMCO	9511-4627	2011-10-03	2012-10-03
Analyzer, Spectrum	E4440A	3Hz - 26.5GHz	Agilent	MY44303352	2011-05-10	2012-05-10

Sentient Energy

Analyzer, Spectrum	HP8591EM	9kHz -1.8 GHz	HP	3916A01477	2011-09-15	2012-09-15

Test Set-up Diagram



Support Equipment

Equipment	Mfr	Model	Serial No.
DC Power Supply	Agilent	E3610A	MY51230030
Laptop PC	Apple	MacBook Pro	C02F58LTDF8V
AC/DC adapter	Apple	A1343	n/a

TEST RESULTS
Radiated Test Set-up, 30 MHz - 9.3 GHz

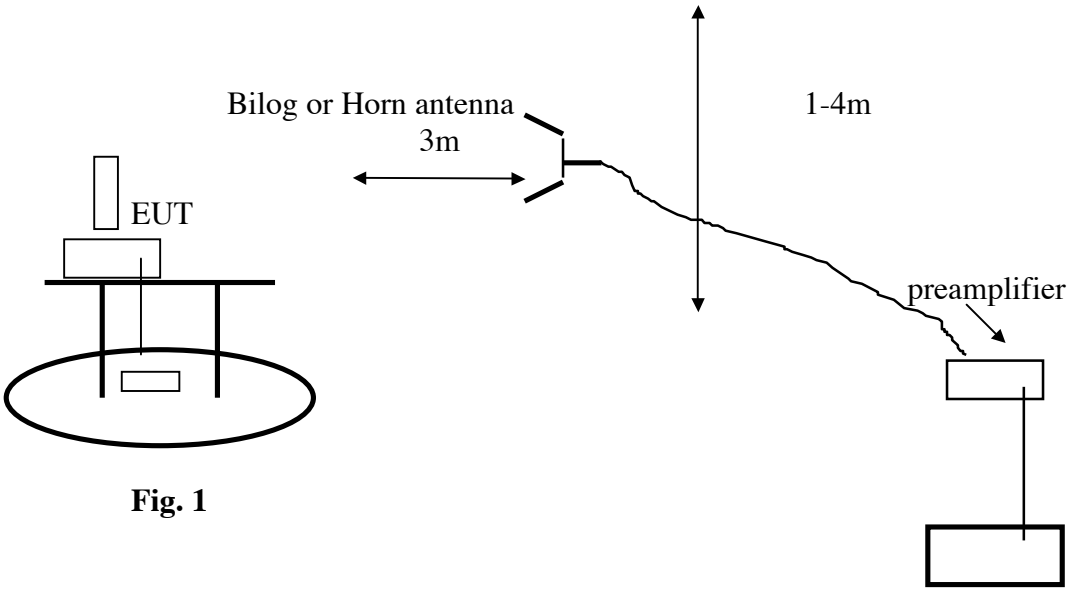


Fig. 1

Test Procedures
Radiated emissions generated by the transmitter portion of the EUT were measured. The output power was set to the maximum power at each frequency based on the original submission. Measured power output levels were within +/- 0.25 dB of original measurements.

1. The EUT was placed on a wooden table resting on a turntable on the test site. The EUT antenna was placed in 3 orthogonal plane orientations to determine which orientation creates maximum output. Orientation producing maximum output is shown in test setup photos. Radiated emissions tests were performed with antenna in this orientation.

The search antenna was placed 3m from the EUT. The EUT antenna was mounted in the with the EUT TX antenna pointed directly to the search antenna.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.

3. Emissions were investigated to the 10^{th} harmonic of the fundamental.

4. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.

Test Results: Worst-case results are presented. Refer to data sheets below. Restricted band emissions meet 54 dBuV/m. Other undesired emissions from the transmitter meet the -20 dBc requirement in 15.247(d).

15.205 Restricted Frequency Bands

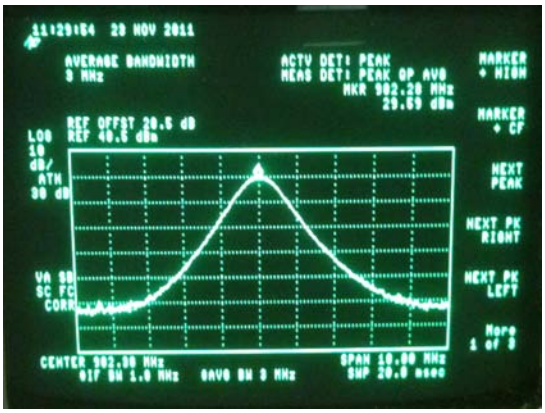
MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505 (1)	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	
13.36 - 13.41	322 - 335.4		

15.209 General Field Strength Limits

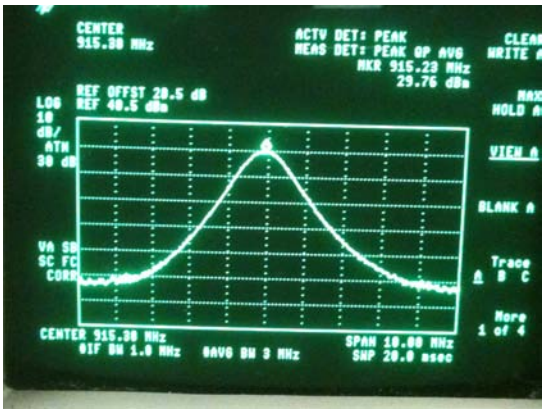
Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/F (kHz)	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

Output Power settings used during tests

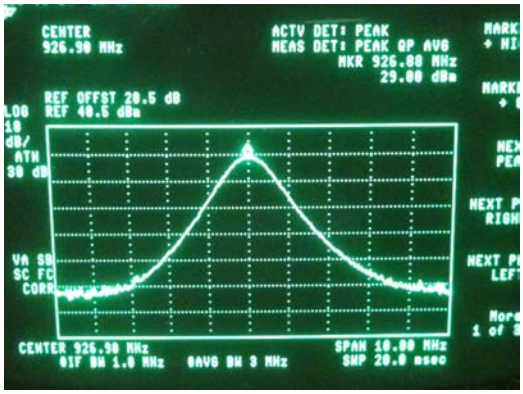
Low channel



Mid channel



High channel



Radiated Emissions Above 1 GHz

LC 902.3 MHz

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	Part 15C		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
1333.45*	47.39	185	100	H				19.82	74	-54.18	Peak
1333.15*	54.74	230	137	V				27.17	74	-46.83	Peak
1333.45*	39.91	185	100	H				12.34	54	-41.66	Avg
1333.15*	52.47	230	137	V				24.9	54	-29.1	Avg
1804.63	42.93	172	100	H	26.72	2.49	27.6	44.57	74	-29.43	Peak
1804.42	48.66	277	100	V	26.56	2.49	27.6	50.14	74	-23.86	Peak
1804.63	37	172	100	H	26.72	2.49	27.6	38.64	54	-15.36	Avg
1804.42	46.5	277	100	V	26.56	2.49	27.6	47.98	54	-6.02	Avg

*From Laptop

MC 915.2 MHz

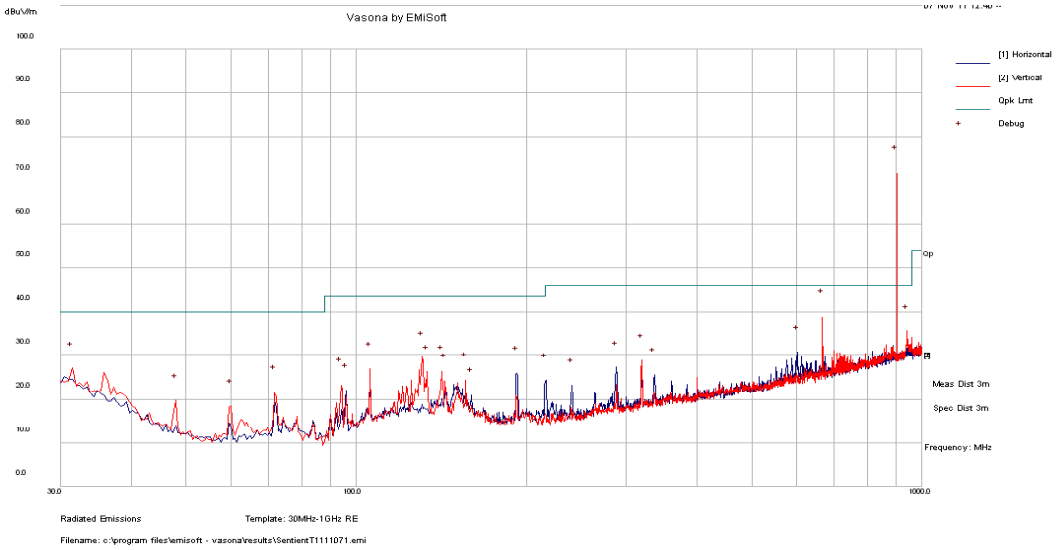
Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	Part 15C		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
1830.38	41.08	56	100	H	26.72	2.49	27.6	42.72	74	-31.28	Peak
1830.17	43.34	277	100	V	26.56	2.49	27.6	44.82	74	-29.18	Peak
1830.38	33.3	56	100	H	26.72	2.49	27.6	34.94	54	-19.06	Avg
1830.17	39.37	277	100	V	26.56	2.49	27.6	40.85	54	-13.15	Avg
				H				-27.57	74	-101.57	Peak
				V				-27.57	74	-101.57	Peak
				H				-27.57	54	-81.57	Avg
				V				-27.57	54	-81.57	Avg

HC 926.9 MHz

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	Part 15C		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
1853.95	40.69	100	100	H	27.16	2.57	27.56	42.85	74	-31.15	Peak
1853.73	43.3	278	100	V	27.03	2.57	27.56	45.33	74	-28.67	Peak
1853.95	30.82	100	100	H	27.16	2.57	27.56	32.98	54	-21.02	Avg
1853.73	38.18	278	100	V	27.03	2.57	27.56	40.21	54	-13.79	Avg
				H				-27.57	74	-101.57	Peak
				V				-27.57	74	-101.57	Peak
				H				-27.57	54	-81.57	Avg
				V				-27.57	54	-81.57	Avg

All other emissions to 10th harmonic more than 20 dB below limits.

Radiated Emissions below 1 GHz



Vasona Data : List of Debug Frequencies

No	Frequency	Raw	dBuV	Cable	Loss	AF	dB	Level	dBuV	Measureme	Pol	Hgt	cm	Azt	Deg	Limit	dBuV	Margin	dB	Pass	/Fail	Comments
1	902.515	60.68	13.47	-2.38	71.77	Peak	[Scan	V	100	0	46	25.77	Fail									
2	666.805	31.33	12.67	-5.04	38.97	Peak	[Scan	V	100	0	46	-7.03	Pass									
3	940.83	24.1	13.57	-2.09	35.58	Peak	[Scan	V	100	0	46	-10.42	Pass									
4	31.455	21.52	10.03	-4.53	27.02	Peak	[Scan	V	100	0	40	-12.98	Pass									
5	130.88	29.78	10.74	-11.04	29.48	Peak	[Scan	V	100	0	43.5	-14.02	Pass									
6	602.3	24.43	12.49	-6.18	30.75	Peak	[Scan	H	100	0	46	-15.25	Pass									
7	105.66	29.39	10.54	-13.03	26.9	Peak	[Scan	V	100	0	43.5	-16.6	Pass									
8	320.03	27.86	11.73	-10.76	28.82	Peak	[Scan	V	100	0	46	-17.18	Pass									
9	133.305	26.65	10.76	-11.16	26.25	Peak	[Scan	V	100	0	43.5	-17.25	Pass									
10	141.55	27.16	10.81	-11.76	26.21	Peak	[Scan	V	100	0	43.5	-17.29	Pass									
11	191.99	27.83	11.07	-12.96	25.94	Peak	[Scan	H	100	0	43.5	-17.56	Pass									
12	71.71	28.21	10.29	-16.97	21.54	Peak	[Scan	V	100	0	40	-18.46	Pass									
13	288.505	27.1	11.55	-11.47	27.18	Peak	[Scan	H	100	0	46	-18.82	Pass									
14	156.1	25.83	10.89	-12.36	24.37	Peak	[Scan	V	100	0	43.5	-19.13	Pass									
15	143.49	25.23	10.82	-11.86	24.19	Peak	[Scan	V	100	0	43.5	-19.31	Pass									

All emissions appeared to be from digital portion of the EUT

MAXIMUM PERMISSIBLE EXPOSURE

LIMITS

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

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 Exposures				
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
300–1500			f/300	6
1500–100,000			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

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

CALCULATIONS

Given

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

and

$S = E ^ 2 / 3770$

where

E = Field Strength in Volts/meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

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

Changing to units of Power to mW and Distance to cm, using:

P (mW) = P (W) / 1000 and
d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$
$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and
G (numeric) = 10 ^ (G (dBi) / 10)

yields

$d = 0.282 * 10 ^ ((P + G) / 20) / \sqrt{S}$ Equation (1)

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Equation (1) and the measured peak power is used to calculate the MPE distance.

LIMITS

From §1.1310 Table 1 (B), S = 0.6 mW/cm^2

RESULTS

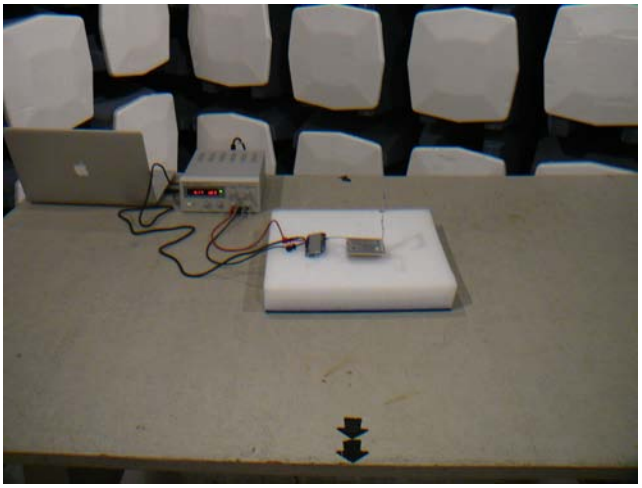
No non-compliance noted:

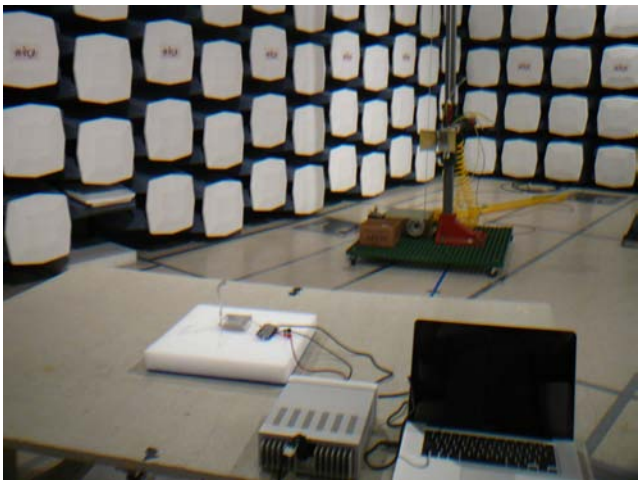
Sentient Energy Inc.									
FCC ID: Z2E-MM2SSN1									
IC: 9908A-MM2SSN1									
RF module for electrical utility data communications						**Calculate mW/cm2 here. Enter frequency in MHz:**			
RF Hazard Distance Calculation						Calculation of Limits from 1.1310 Table 1			
								Controlled	Uncontrolled
								Ave 6 min	Ave 30 min
mW/cm2 from Table1:		0.60	(E: 61 V/m)			F(MHz)	**Actual F, MHz**	Occ, mW/c2	Gen, mW/cm2
						0.3-3	0.5	100.0	100.0
Max RF Power	TX Antenna	MPE distance	S, mW/cm@	Comment		*3.0 - 30.0*	*5*	*180.0*	*36.0*
P, dBm	G, dBi	cm	at 20 cm			**30.0-300**	**55**	**1.0**	**0.2**
						300-1500	*902*	*3.0*	*0.60*
29.8	**4.0**	**17.8**	**0.47**			1500-100000	5555	5.0	1.0
						Enter P(mW)	Equivalent dBm	**Enter dBm**	Equivalent Watts
Basis of Calculations:						***64***	**18.1**	***18.1***	64.6
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@20cm = 20 log (MPE dist/20cm)									
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									

MPE Distance: 17.8 cm

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

SETUP PHOTOS





END OF REPORT

Report Revision History

Revision No.	Revision Description	Pages Revised	Revised by	Date
-	Original Issue		T. Cokenias	11/17/2011
1	Add biconical antenna calibration information Correct support equipment information Add output power plots Confirm tested antenna orientation as worst case	3,4,6	T. Cokenias	11/23/2011