L.S. Compliance, Inc.
W66 N220 Commerce Court
Cedarburg, WI 53012
262-375-4400 Fax: 262-375-4248

COMPLIANCE TESTING OF:

Heat-Timer 900 MHz RF Module

Prepared For:

Heat-Timer Corporation
Attention: Mr. Oron Brokman
20 New Dutch Lane
Fairfield, NJ 07004
U.S.A.

Test Report Number:

305440-Tx-v1

Test Dates:

February 8TH, through 24TH, 2006

Table of Contents

Section	Description	Page
Index		2
1	L. S. Compliance in Review	3
2	Signature Page	4
3	Product and General Information	5
4	Introduction	5
5	Product Description	6-7
6	Test Requirements	8
7	Summary of Test Report	8
8	Radiated Emissions Test	9-25
9	Band-Edge Measurements	26
10	Conducted Emissions onto AC Power Line	27-31
11	Occupied Bandwidth	32-33
12	RF Power Output	34-35
13	Spurious RF Emissions	36-37
14	Minimum Channel Separation	38-41
15	Channel Occupancy	42-44
16	Frequency and Power Stability requirements	45
17	Equal Channel Usage	46
18	Pseudorandom Hopping Pattern	46
19	Receiver Synchronization	47
20	Receiver Input Bandwidth	47
21	MPE Calculations	48
Appendix		
A	Test Equipment List	49
B	Antenna Specification Sheets	50-52
C	Firmware and Setup Instructions	53

1. L. S. Compliance In Review

L.S. Compliance - Accreditations and Listing's

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025 : 1999
with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01

Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1
File Number: IC 3088-A

On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1
File Number: IC 3088

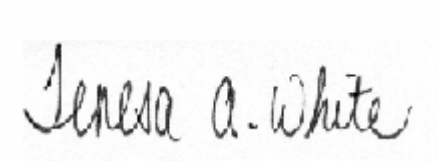
U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2)
Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

Date of Validation: November 20, 2002
Notified Body Identification Number: 1243

2. Signature Page



Prepared By: March 9, 2006

Teresa A. White, Document Coordinator Date

Tested By: March 9, 2006

Abtin Spantman, EMC Engineer Date

Approved By: March 9, 2006

Brian E. Petted, VP of Engineering Date

3. Product and General Information

Manufacturer:	Heat-Timer Corporation					
Date(s) of Test:	February 8TH through 24TH, 2006					
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	900 MHz RF Module					
Serial #:	05510529 and 05510534					
Voltage:	3.3 VDC					
Operation Mode:	Normal, continuous modulated transmit, and 'Hopping' mode					

4. Introduction

Between February 8TH and 24TH, 2006, a series of Conducted and Radiated RF Emission tests were performed on two samples of the Heat-Timer Corporation's 900 MHz RF Modules, serial numbers 05510529 and 05510534, here forth collectively referred to as the "*Equipment Under Test*" or "*EUT*". These tests were performed using the procedures outlined in ANSI C63.4-2003 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.247 (Industry Canada RSS-210) for a low power transmitter. These tests were performed by Abtin Spantman, EMC Engineer at L.S. Compliance, Incorporated.

All Radiated and Conducted RF Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in FCC Title 47 CFR Part 15, including 15.35, 15.209, 15.247 and Industry Canada RSS-210 to determine whether these emissions are below the limits expressed within the standards. These tests were performed in accordance with the procedures described in the 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 (ANSI C63.4-2003). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelelectriques (CISPR) Number 16-1, 2003.

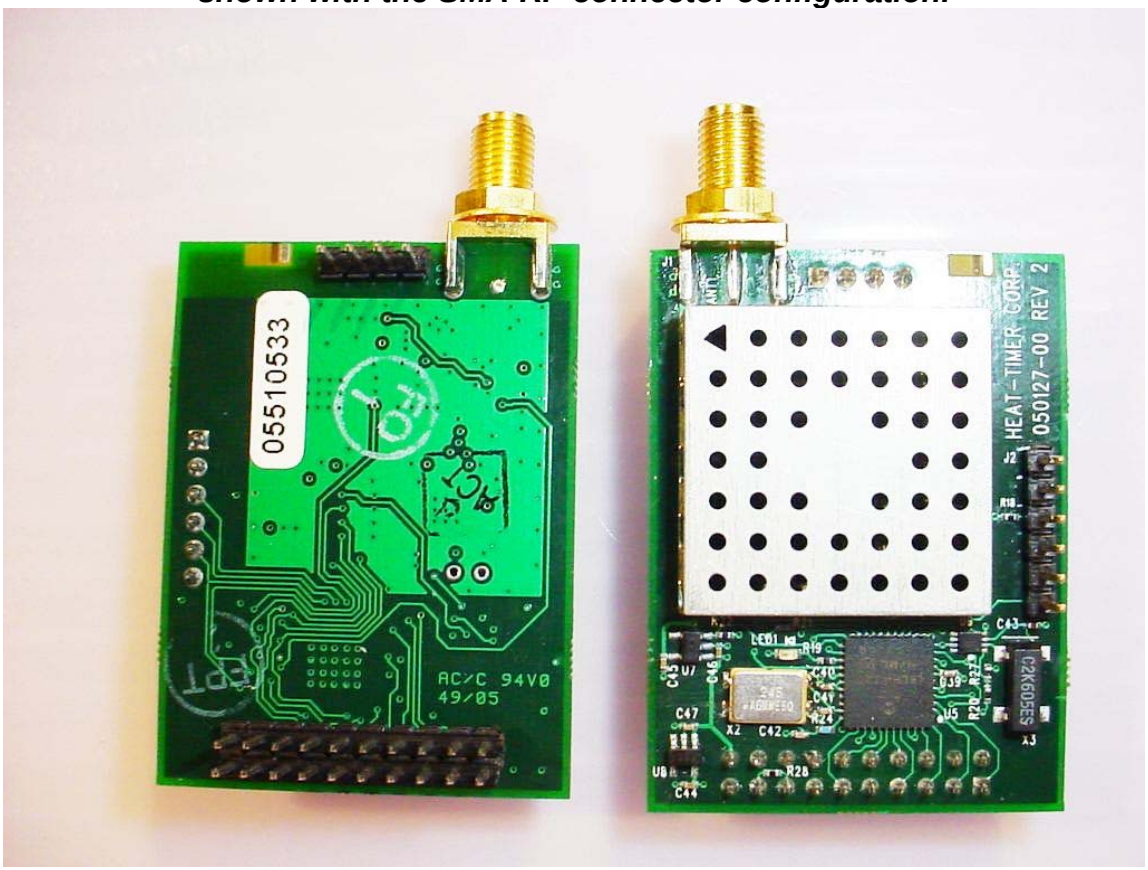
All tests were performed at L.S. Compliance, Inc., in Cedarburg, Wisconsin, unless otherwise noted.

5. Product Description

The Heat-Timer 900 MHz RF Module is a Frequency Hopping transceiver module operating in the 902-928 MHz ISM band, as qualified under 47CFR Part 15.247. The transmit characteristics of this transceiver were tested and the results are covered in this report.

The module has a 3.3 VDC, 175 mA nominal voltage and current requirement, and is designed to operate on 25 channels, with a nominal RF power output of 250 mW. The module may be powered from batteries or from AC wall adaptors. Power and data pins are available through a standard 0.1" header on the module. The module may be fitted with a reverse gendered SMA connector for the different antennas, or with a wire whip antenna directly soldered onto the module. The Module is based on a single chip RF transceiver processor, which is capable of operating at 200 kbps, with FSK modulation techniques.

The Heat-Timer 900 MHz RF Transceiver Module, shown with the SMA-RP connector configuration.

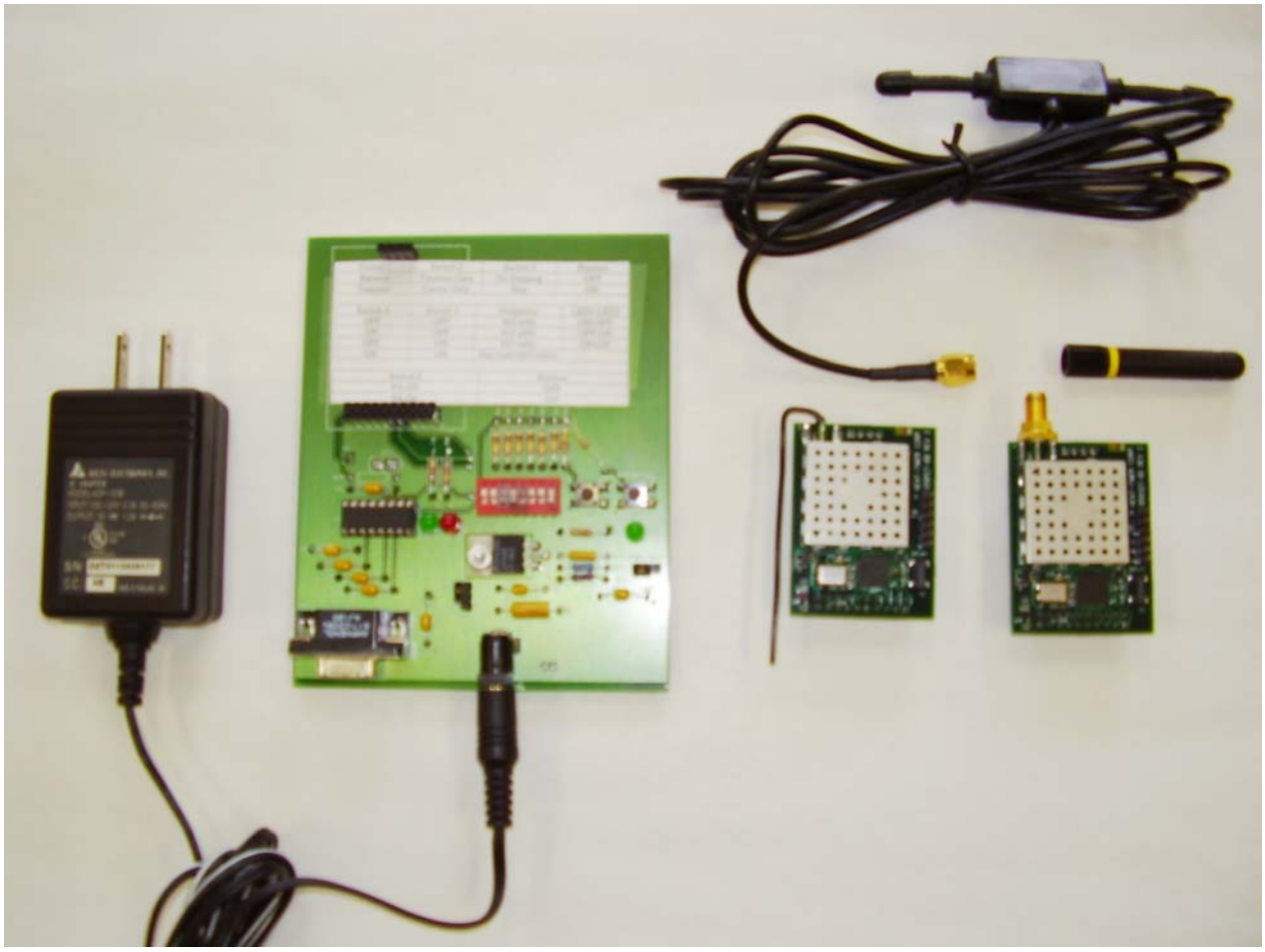


The Module is tested and qualified in three types of antenna configurations:

Configuration	Antenna MFG	Model
1	Antenna Factor	ANT-916-CW-RH
2	Antenna Factor	ANT-916-MHW-RPS
3	“Generic Wire Whip”	8 cm long, 22 AWG

The Module was placed in test modes using a special test-board fixture, with an on-board RS-232 translator, and programming dip switches. The module was connected to the test-board fixture using and extension ribbon cable.

The Modules and antenna configurations shown on the right,
And the test-board fixture shown on the left.



6. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the transmitter portion of the ***Heat-Timer "900 MHz RF Module"*** with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.205	15.247a	15.247d
15.207	15.247b	15.247g
15.209	15.247c	15.247i

7. Summary of Test Report

DECLARATION OF CONFORMITY

The ***Heat-Timer "900 MHz RF Module"*** was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 15.247, and Industry Canada RSS-210, Section 6.2.2(o) for a Frequency Hopping Spread Spectrum Transmitter.

The enclosed test results pertain to the sample(s) of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

Some emissions are seen to be within 3dB of their respective limits. As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

8. Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit mode, using power as provided by a wall type power supply. The unit has the capability to operate on 25 channels, controllable via dip switches, on a custom test-fixture board during the testing.

The applicable limits apply at a 3 meter distance. Measurements above 1 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (903.0 MHz), middle (915.0 MHz) and high (927.0 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using DIP-switches on the test-fixture board, and monitored via a lap-top PC.

Three antenna configurations are tested and qualified with the module in this report. The antenna specifications can be found in the appendices.

Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 10000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

The EUT was rotated along three orthogonal axis during the investigations to find the highest emission levels.

Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 5 GHz to 10 GHz, an HP E4407 Spectrum Analyzer and an EMCO Horn Antenna were used.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a FHSS transmitter [Canada RSS-210, Clause 6.2.2(0)]. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 902-928 MHz band, as specified in 47 CFR 15.247 (b)(2), is 0.25 Watts for systems employing less than 50 hopping channels, but at least 25 hopping channels. The harmonic and spurious RF emissions, as measured in any 100kHz bandwidth, as specified in 15.247 (d), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c).

The following table depicts the Class B limits for an unintentional radiator. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands.

Frequency (MHz)	3 m Limit (μV/m)	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-25,000	500	54.0	63.5

Sample calculations:

Sample conversion from a field conducted RF power measurement in mW to a radiated Electric-Field Intensity (EFI) measurement in dBμV/m would be:

$$dB\mu V/m@3m = 95.23 + 10Log_{10}\left(\frac{XXmW}{1mW}\right)$$

AT the fundamental frequency, the limit for the RF power output of 0.25W (250mW) at the antenna port of a transmitter with an antenna gain of 0 dBi would be equivalent to an Equivalent Isotropic Radiated Power (e.i.r.p.) measurement of 119.2 dBμV/m at 3 meters.

$$119.23dB\mu V/m@3m = 95.23 + 10Log_{10}\left(\frac{250mW}{1mW}\right)$$

Note: 47CFR 15.247 (b)(4) allows use of antennas with directional gains up to 6 dBi , which in effect allows for the EFI Limit to be increased by 6 dB.

When invoking 15.247 (b)(4), the effective EFI Limit is:
Effective EFI Limit = 119.2 dBμV/m + 6 dB = 125.2 dBμV/m @ 3m.

~ ~

Sample conversion from a measurement distance of 3 meters to a distance of 1meter would be:

$$dB = -20Log_{10}\left(\frac{XXm}{3m}\right)$$

A sample limit, within the frequency range of 960-25,000 MHz for example, when measured at 1 meter instead of 3 meters would change according to the equation:

$$63.5dB\mu V/m = 54.0dB\mu V/m + \left(-20Log_{10}\left(\frac{1m}{3m}\right)\right)$$

Radiated Emissions Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: 47CFR, Part 15.205 and 15.247(FHSS)
Frequency Range Inspected: 30 MHz to 10000 MHz

Manufacturer:	Heat-Timer Corporation							
Date(s) of Test:	February 8TH through 24TH, 2006							
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston		
Model #:	900 MHz RF Module							
Serial #:	05510529 and 05510534							
Voltage:	3.3 VDC							
Operation Mode:	Normal, continuous modulated transmit, and 'Hopping' mode							
EUT Power:		Single Phase ___VAC				3 Phase ___VAC		
		Battery			√	Other: Bench DC Supply		
EUT Placement:	√	80cm non-conductive table				10cm Spacers		
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber				3/10m OATS		
Measurements:		Pre-Compliance		Preliminary		√	Final	
Detectors Used:		Peak	√	Quasi-Peak		√	Average	

Environmental Conditions in the Lab:
Temperature: 20 – 25°C
Relative Humidity: 30 – 60 %

Test Equipment Used:
EMI Measurement Instrument: HP8546A and Agilent E4407B
Log Periodic Antenna: EMCO #93146
Horn Antenna: EMCO #3115
Biconical Antenna: EMCO 93110
Pre-Amp: Advanced Microwave WLA622-4

Tabulated data for all three antenna configurations are presented on the following 4 pages.

The following table depicts the level of significant spurious radiated RF emissions found:

Frequency (MHz)	Ant. Pol. Sens/EUT	Channel / Configur.	Height (m)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
49.2	V / S	H / 2	1.00	135	34.4	40.0	5.6
55.3	V / S	H / 2	1.00	135	37.4	40.0	2.6
61.5	V / S	H / 2	1.00	130	39.1	40.0	0.9
73.7	V / S	H / 2	1.00	90	38.2	40.0	1.8
104.5	V / S	H / 2	1.00	175	38.2	43.0	4.8
133.2	V / S	H / 2	1.00	55	38.1	43.0	4.9
178.2	V / S	H / 2	1.00	55	32.3	43.0	10.7
608.8	H / H	L / 2	1.30	180	30.7	46.0	15.3
790.2	V / V	L / 1	1.15	0	62.3	99.0 (Note 2)	36.7
800.7	H / H	M / 3	1.00	60	55.3	101.4 (Note 2)	46.1
839.1	H / H	L / 3	1.00	55	59.8	102.1 (Note 2)	42.3
846.7	H / H	L / 3	1.00	55	55.4	102.1 (Note 2)	46.7
851.1	H / H	M / 3	1.00	60	60.0	101.4 (Note 2)	41.4
862.9	H / H	H / 3	1.60	55	54.6	99.8 (Note 2)	45.2
870.9	H / H	L / 3	1.00	55	58.8	102.1 (Note 2)	43.3
887.1	V / V	L / 2	1.10	130	65.7	101.5 (Note 2)	35.8
895.1	H / H	H / 3	1.60	55	55.4	99.8 (Note 2)	44.4
928.2	H / H	H / 3	1.60	55	55.6	99.8 (Note 2)	44.2
931.1	V / V	M / 1	1.10	45	62.1	98.4 (Note 2)	36.3
935.1	V / V	L / 1	1.15	0	50.2	99.0 (Note 2)	48.8
942.9	V / V	H / 1	1.10	60	60.8	97.5 (Note 2)	36.7
946.9	V / V	M / 1	1.10	45	49.2	98.4 (Note 2)	49.2
958.9	H / H	H / 2	1.25	155	52.9	100.9 (Note 2)	48.0
974.9	H / H	H / 2	1.25	155	46.4	54.0	7.6
979.1	H / H	M / 3	1.00	60	46.3	54.0	7.7
990.9	H / H	H / 2	1.25	155	51.4	54.0	2.6
990.9	H / H	H / 3	1.60	55	47.8	54.0	6.2

Notes:

1) A Quasi-Peak Detector was used in measurements below 1 GHz, and an Average Detector was used in measurements above 1 GHz. The Peak detector was also use to ensure that the emission levels do not exceed 20 dB beyond the Average limits. No significant spurious emissions observed. All spurious emissions were better than 20 dB below the limits.

2) The limit is expressed as (-20 dBc) under the 15.247 guidelines, with respect to the appropriate center frequency of operation.

3) Measurements above 5 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation for frequencies between 18-25 GHz.

4) Measurement at receiver system noise floor.

5) "Ant. Pol. Sens/EUT" column indicates the orientation of the EUT with respect to the sense antenna. The notation is defined as: Vertical="V", Horizontal="H" and Side="S".

Antenna Configuration 1 : (ANT-916-CW-RH)

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Low Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
903	V / V	1.10	0	119.0	125.2	6.2
1806	V / S	1.00	80	55.4	108.5	53.1
2709	V / H	1.00	90	46.1	63.5	17.4
3612	V / H	1.00	0	48.2	63.5	15.3
4515	H / H	1.00	0	47.8	63.5	15.7
5418	H / S	1.00	330	50.0	63.5	13.5
6321	H / S	1.00	90	45.0	108.5	63.5
7224	H / S	1.00	70	41.7	108.5	66.8
8127	H / S	1.15	270	38.7	63.5	24.8
9030	H / S	1.15	270	40.0	63.5	23.5

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Mid Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
915	V / V	1.10	45	118.4	125.2	6.8
1830	V / S	1.25	270	63.5	107.9	44.4
2745	V / H	1.00	90	45.7	63.5	17.8
3660	V / H	1.00	0	47.9	63.5	15.6
4575	H / H	1.00	90	47.5	63.5	16.0
5490	H / S	1.25	85	51.3	107.9	56.6
6405	H / S	1.20	175	48.8	107.9	59.1
7320	H / S	1.10	5	41.7	63.5	21.8
8235	H / S	1.00	170	35.5	63.5	28.0
9150	H / S	1.00	30	39.6	63.5	23.9

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on High Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927	V / V	1.10	60	117.5	125.2	7.7
1854	V / S	1.00	175	61.2	107.0	45.8
2781	V / H	1.00	90	46.2	63.5	17.3
3708	V / H	1.00	0	48.0	63.5	15.5
4635	H / H	1.00	270	47.8	63.5	15.7
5562	H / S	1.20	85	49.4	107.0	57.6
6489	H / S	1.15	175	45.1	107.0	61.9
7416	H / S	1.05	10	43.2	63.5	20.3
8343	H / S	1.05	210	35.8	63.5	27.7
9270	H / S	1.05	330	40.4	107.0	66.6

Antenna Configuration 2 : (ANT-916-MHW-RPS)

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Low Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
903	V / V	1.30	180	121.5	125.2	3.7
1806	H / V	1.00	45	64.8	111.0	46.2
2709	H / V	1.00	0	50.3	63.5	13.2
3612	H / V	1.00	0	52.4	63.5	11.1
4515	H / V	1.00	0	52.2	63.5	11.3
5418				(Note 4)	63.5	
6321				(Note 4)	111.0	
7224				(Note 4)	111.0	
8127				(Note 4)	63.5	
9030				(Note 4)	63.5	

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Mid Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
915	V / V	1.30	155	121.3	125.2	3.9
1830	H / V	1.00	40	63.3	110.8	47.5
2745	H / V	1.00	0	50.4	63.5	13.1
3660	H / V	1.00	0	52.5	63.5	11.0
4575	H / V	1.00	0	52.2	63.5	11.3
5490				(Note 4)	110.8	
6405				(Note 4)	110.8	
7320				(Note 4)	63.5	
8235				(Note 4)	63.5	
9150				(Note 4)	63.5	

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on High Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927	V / V	1.30	155	120.9	125.2	4.3
1854	H / V	1.00	20	64.5	110.4	45.9
2781	H / V	1.00	0	50.6	63.5	12.9
3708	H / V	1.00	0	52.5	63.5	11.0
4635	H / V	1.00	0	52.3	63.5	11.2
5562				(Note 4)	110.4	
6489				(Note 4)	110.4	
7416				(Note 4)	63.5	
8343				(Note 4)	63.5	
9270				(Note 4)	110.4	

Antenna Configuration 3 : (Generic Wire Whip)

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Low Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
903	H / H	1.00	55	122.1	125.2	3.1
1806	H / V	1.00	100	62.9	111.6	48.7
2709	H / V	1.00	90	51.4	63.5	12.1
3612	H / V	1.00	0	52.6	63.5	10.9
4515	H / V	1.00	0	52.6	63.5	10.9
5418				(Note 4)	63.5	
6321				(Note 4)	111.6	
7224				(Note 4)	111.6	
8127				(Note 4)	63.5	
9030				(Note 4)	63.5	

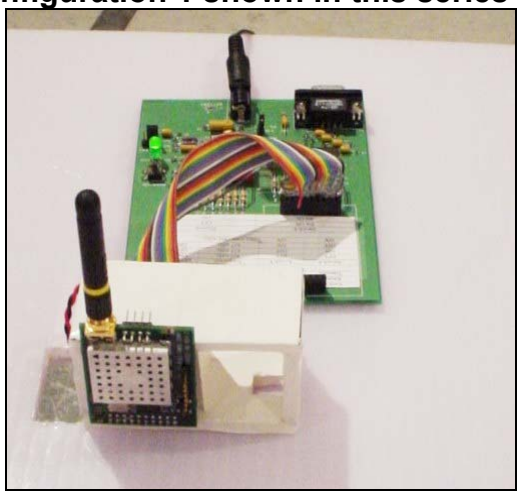
The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Mid Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
915	H / H	1.00	60	121.4	125.2	3.8
1830	H / V	1.05	190	66.9	110.9	44.0
2745	H / V	1.00	0	50.8	63.5	12.7
3660	H / V	1.00	0	52.4	63.5	11.1
4575	H / V	1.00	0	52.4	63.5	11.1
5490				(Note 4)	110.9	
6405				(Note 4)	110.9	
7320				(Note 4)	63.5	
8235				(Note 4)	63.5	
9150				(Note 4)	63.5	

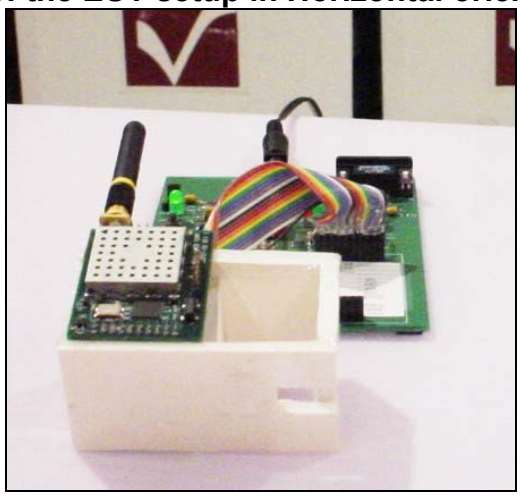
The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on High Channel:

Frequency (MHz)	Ant. Pol. Sens/EUT	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927	H / H	1.60	55	119.8	125.2	5.4
1854	H / V	1.00	120	66.0	109.3	43.3
2781	H / V	1.00	0	50.9	63.5	12.6
3708	H / V	1.00	0	52.7	63.5	10.8
4635	H / V	1.00	0	52.4	63.5	11.1
5562				(Note 4)	109.3	
6489				(Note 4)	109.3	
7416				(Note 4)	63.5	
8343				(Note 4)	63.5	
9270				(Note 4)	109.3	

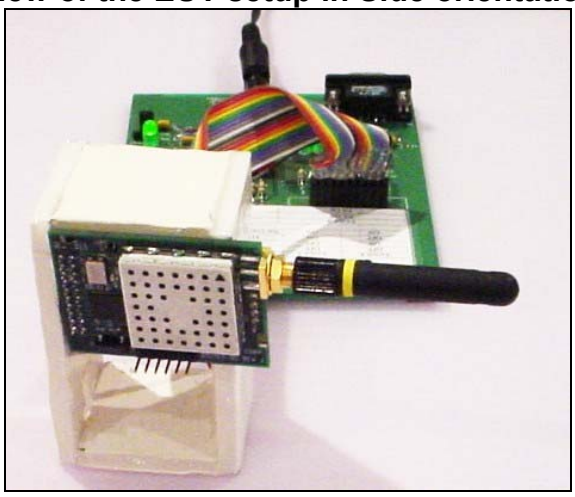
View of the EUT setup in vertical orientation
Antenna configuration 1 shown in this series of photos.



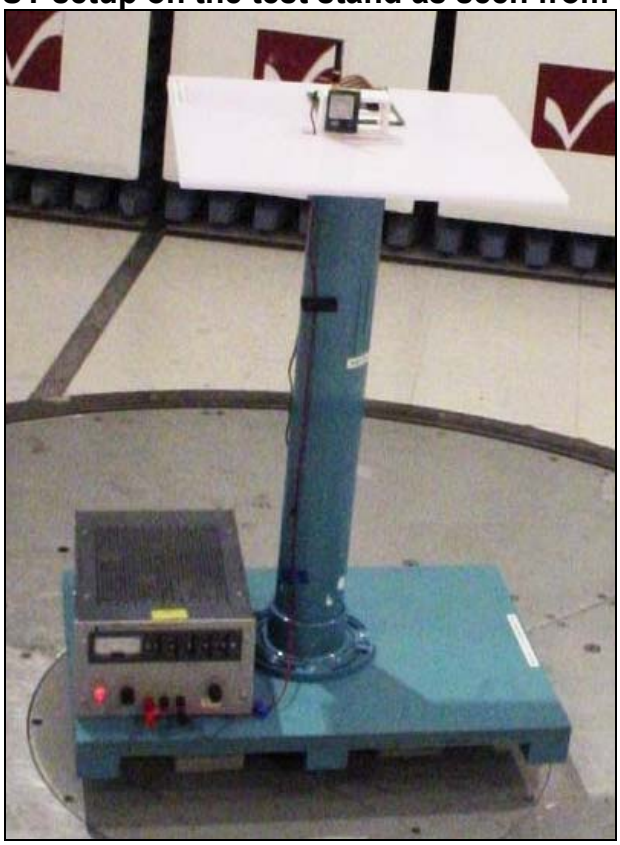
View of the EUT setup in Horizontal orientation



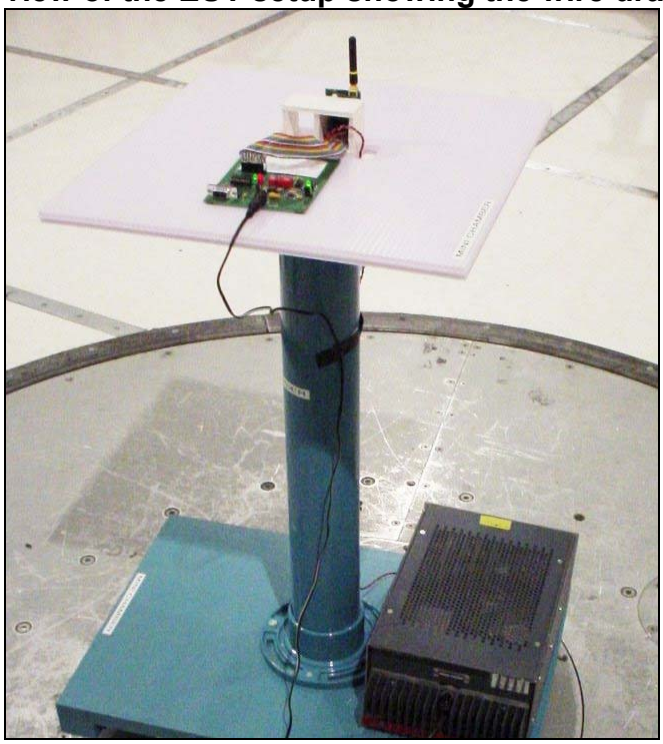
View of the EUT setup in Side orientation



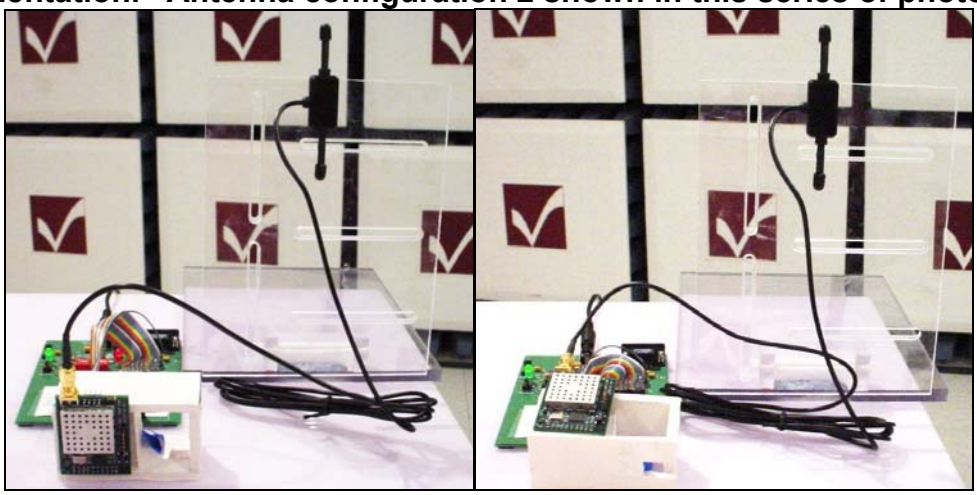
Front view of the EUT setup on the test stand as seen from the sense antenna.



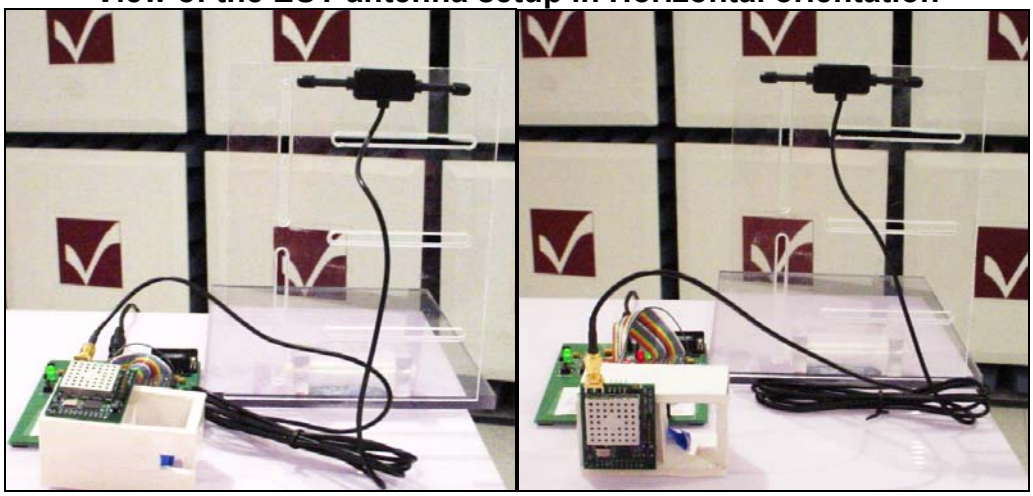
Rear view of the EUT setup showing the wire draping.



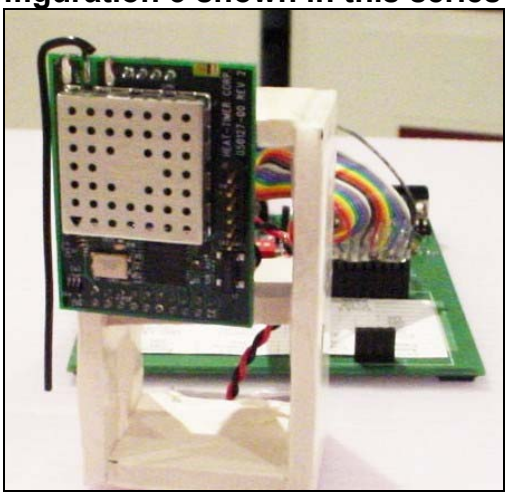
View of the EUT antenna defined in vertical orientation, with module PCB in various orientation. Antenna configuration 2 shown in this series of photos.



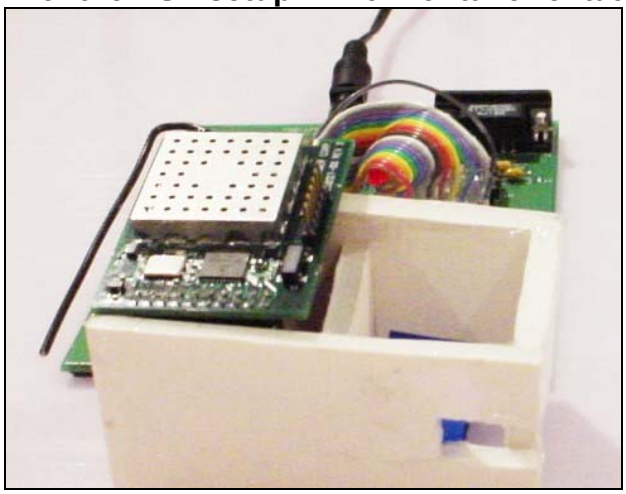
View of the EUT antenna setup in Horizontal orientation



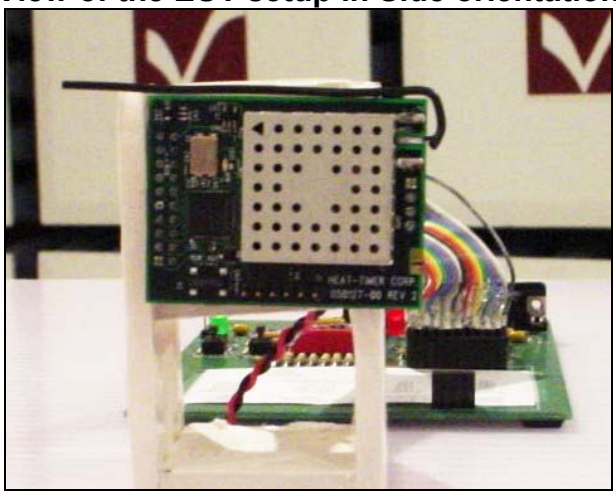
View of the EUT setup in vertical orientation
Antenna configuration 3 shown in this series of photos.



View of the EUT setup in Horizontal orientation



View of the EUT setup in Side orientation



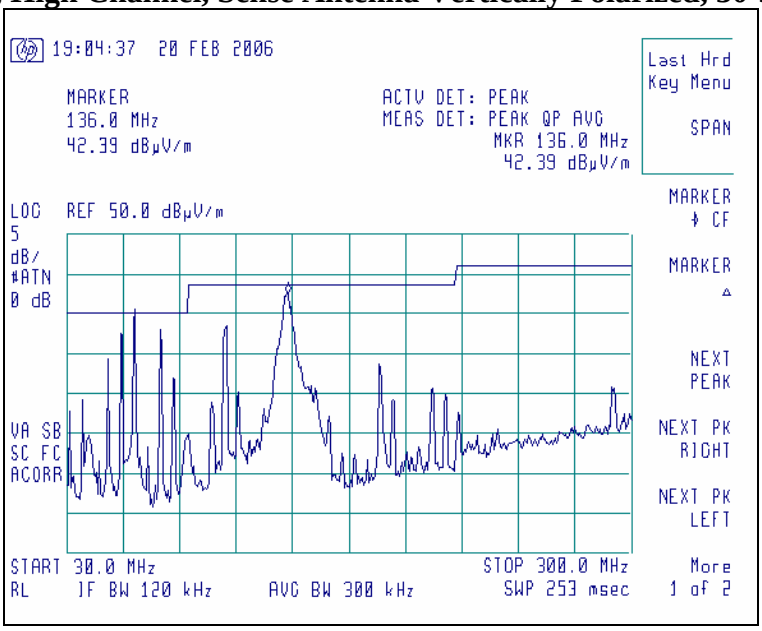
Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions:

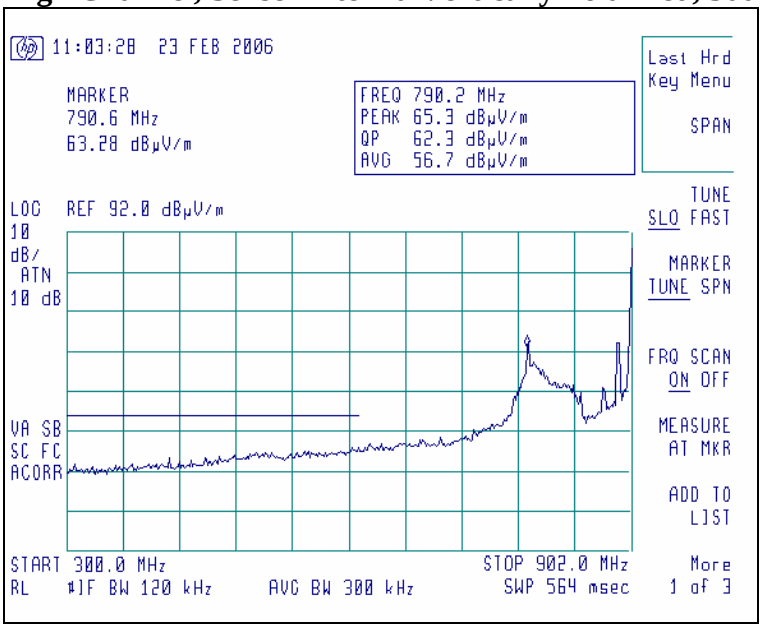
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions among all three antennas tested, as measured on Low, Middle and High channels, and with the sense and EUT antennas both in vertical polarity for worst case presentations.

Configuration 2, High Channel, Sense Antenna Vertically Polarized, 30-300 MHz, at 3m.

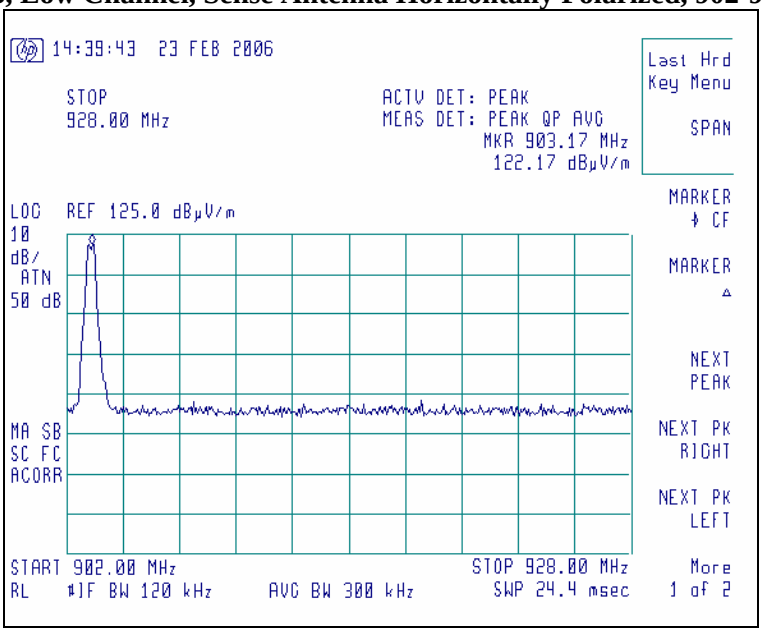


Configuration 1, High Channel, Sense Antenna Vertically Polarized, 300-902 MHz, at 3m.



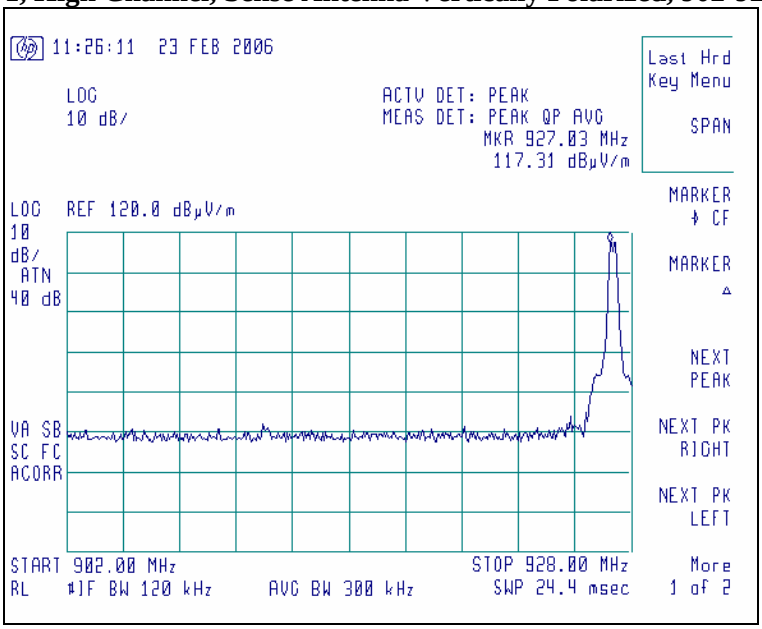
Highest Measured EFI at Fundamental Frequencies:

Configuration 3, Low Channel, Sense Antenna Horizontally Polarized, 902-928 MHz, at 3m.

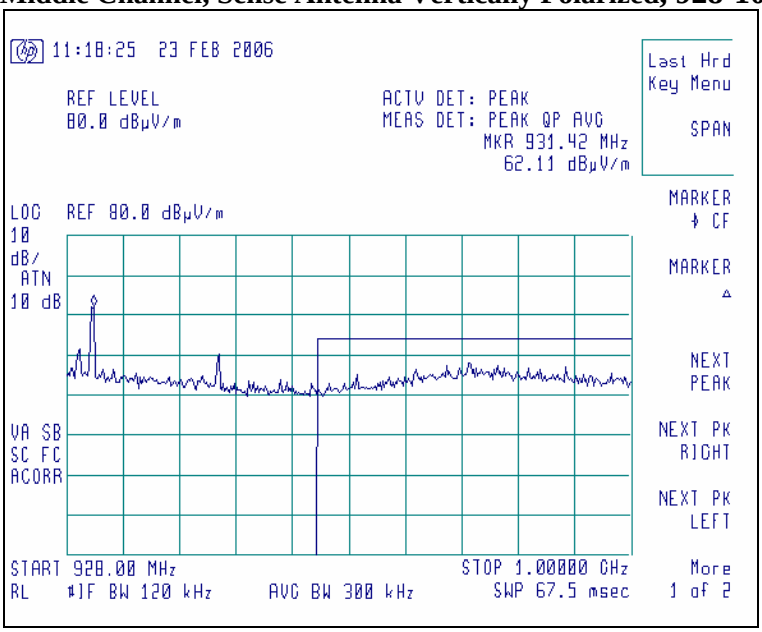


Lowest Measured EFI at Fundamental Frequencies:

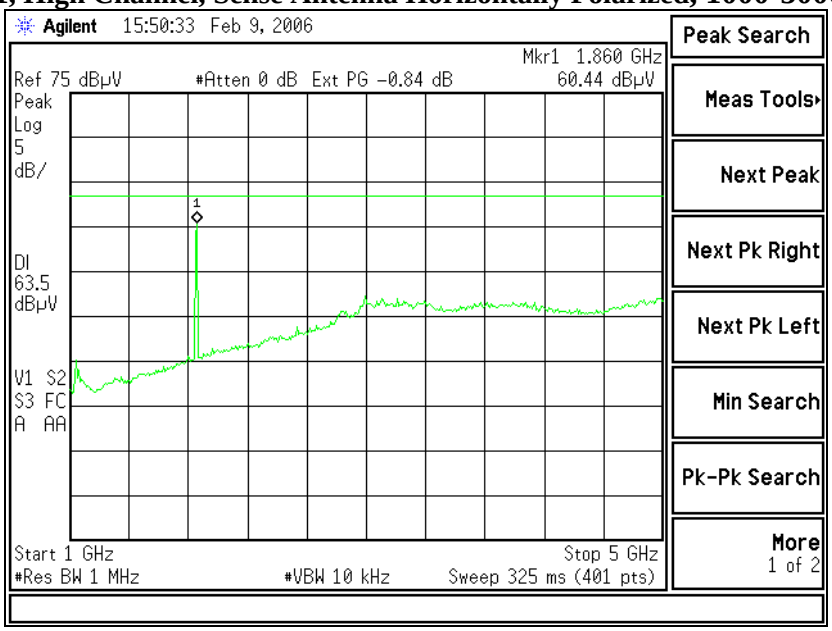
Configuration 1, High Channel, Sense Antenna Vertically Polarized, 902-928 MHz, at 3m.



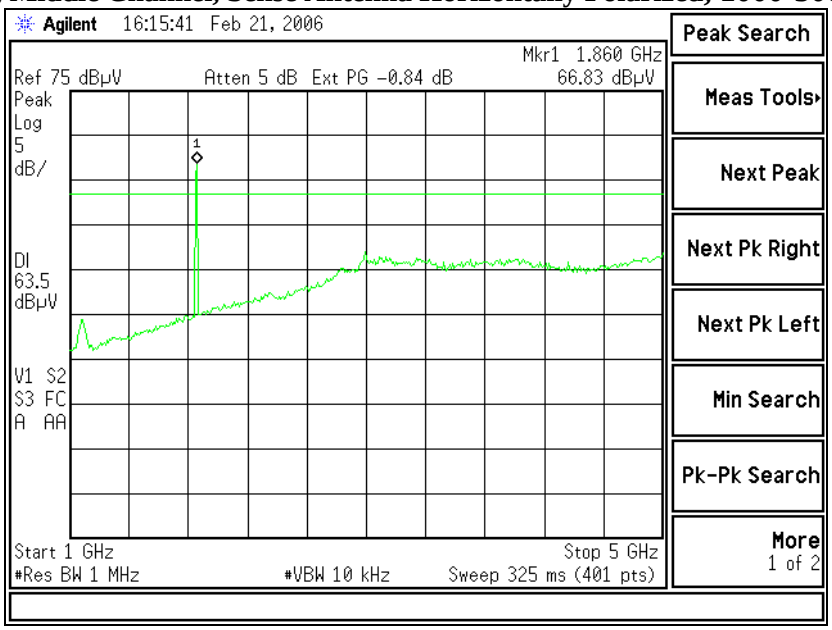
Configuration 1, Middle Channel, Sense Antenna Vertically Polarized, 928-1000 MHz, at 3m.



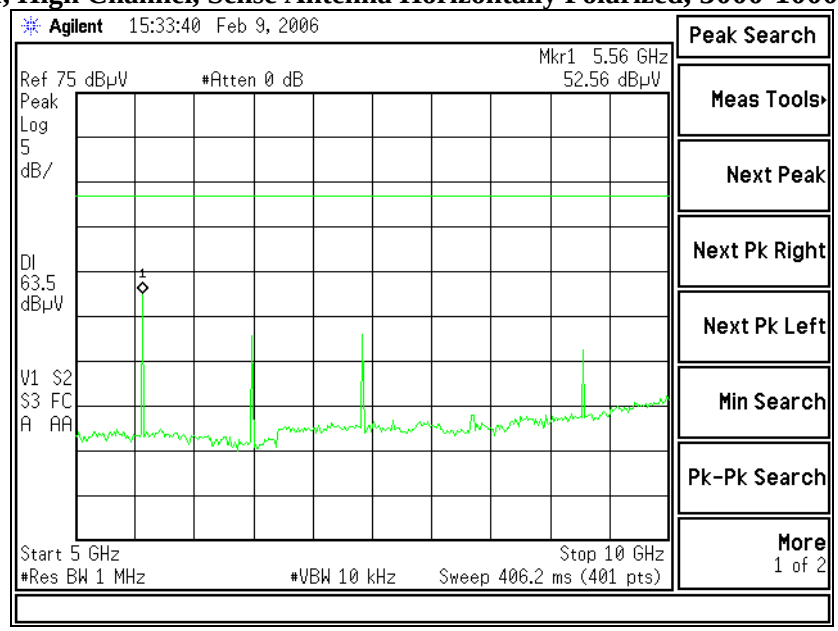
Configuration 1, High Channel, Sense Antenna Horizontally Polarized, 1000-5000 MHz, at 1m.



Configuration 3, Middle Channel, Sense Antenna Horizontally Polarized, 1000-5000 MHz, at 1m.



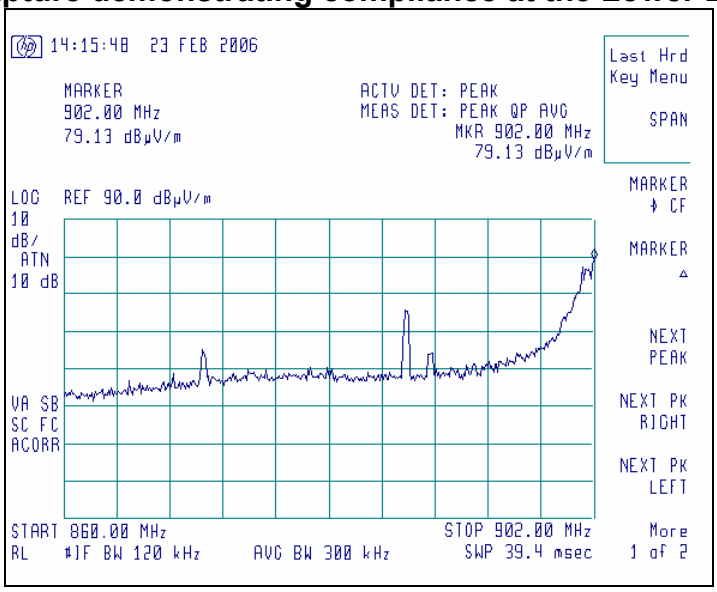
Configuration 1, High Channel, Sense Antenna Horizontally Polarized, 5000-10000 MHz, at 1 m.



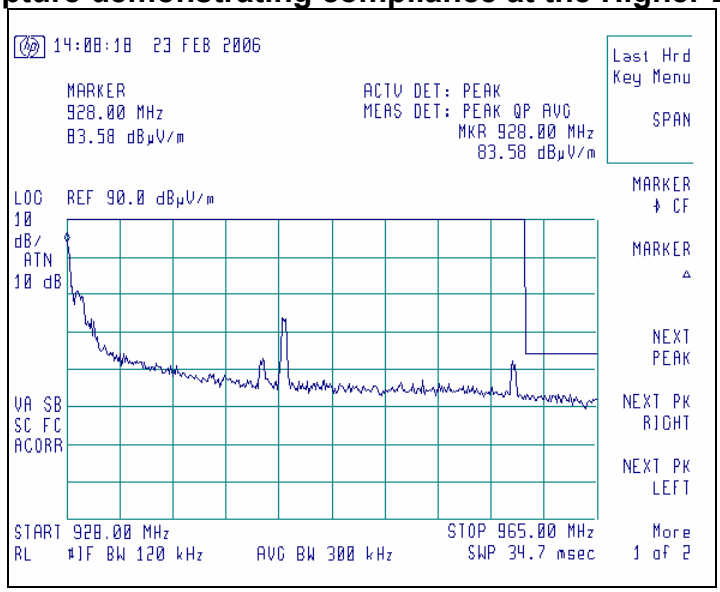
9. Band-Edge Measurements

FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the band-edges where the intentional radiator operates. The following screen captures demonstrate compliance of the intentional radiator at the 902 - 928 MHz band-edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower band-edge, and at the highest channel for the investigation of the higher band-edge.
The screen captures on the following pages demonstrate compliance of the intentional radiator at the 902-928 MHz band-edges, with emissions meeting the – 20 dBc limit.

Configuration 2 presented here with highest emissions.
Screen Capture demonstrating compliance at the Lower Band-Edge



Screen Capture demonstrating compliance at the Higher Band-Edge



10. Conducted RF Emissions onto AC Power Line

Test Setup

The Conducted Emissions test was performed at L.S. Compliance, Inc. in Cedarburg, Wisconsin. The test area and setup are in accordance with ANSI C63.4-2003 and with Title 47 CFR, FCC Part 15 (Industry Canada RSS-210). The EUT was placed on a non-conductive pedestal, with a height of 80 cm above the reference ground plane.

Power and data was provided to the EUT module by the custom test-fixture board, which in turn received power from a typical wall type AC-adaptor, rated 5.0 VDC, 100 mA output. The AC adaptor was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). AC power of 120V, 60 Hz was provided via an appropriate broadband EMI Filter, and then to the LISN line input. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1 (2003), Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30MHz. Final readings were then taken and recorded.

Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. Calibrations of the LISN and Limiter are traceable to N.I.S.T. All cables are calibrated and checked periodically for conformance. The emissions are measured on the HP 8546A EMI Receiver, which has automatic correction for all factors and allows direct measurements.

Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Calculation of Conducted Emissions Limits

The following table describes the Class B limits for an intentional radiator. These limits are obtained from Title 47 CFR, Part 15.107 (a) for Conducted Emissions.

Frequency (MHz)	Quasi-Peak Limit (dBµV)	Average Limit (dBµV)
0.15 – 0.5	66 – 56 *	56 – 46
0.5 – 5.0	56	46
5.0 – 30.0	60	50

10Decreases with the logarithm of the frequency.

Sample calculation for the limits in the 0.15 to 0.5 MHz:

$$\text{Limit} = -19.12 \left(\text{Log}_{10} \left(F[\text{MHz}] / 0.15 [\text{MHz}] \right) \right) + 66.0 \text{ dB}\mu\text{V}$$

For a frequency of 200 kHz for example:

$$\text{Quasi-Peak Limit (F = 200kHz)} = -19.12 \left(\text{Log}_{10} \left(0.2[\text{MHz}] / 0.15 [\text{MHz}] \right) \right) + 66.0 \text{ dB}\mu\text{V}$$

$$\text{Quasi-Peak Limit (F = 200kHz)} = 63.6 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F=200kHz)} = -19.12 \left(\text{Log}_{10}(0.2[\text{MHz}]/0.15[\text{MHz}]) \right) + 56.0 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F = 200 kHz)} = 53.6 \text{ dB}\mu\text{V}$$

Measurement of Electromagnetic Conducted Emission

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 (a)

Manufacturer:	Heat-Timer Corporation					
Date(s) of Test:	February 8TH through 24TH, 2006					
Test Engineer:		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	900 MHz RF Module					
Serial #:	05510529 and 05510534					
Voltage:	3.3 VDC					
Operation Mode:	Normal, continuous modulated transmit, and 'Hopping' mode					
Test Location:					√	Chamber
EUT Placed On:	√	40cm from Vertical Ground Plane				10cm Spacers
	√	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	√	Final
Detectors Used:		Peak	√	Quasi-Peak	√	Average

Environmental Conditions in the Lab:
Temperature: 20 – 25° C
Atmospheric Pressure: 86 kPa – 106 kPa
Relative Humidity: 30 – 60%

Test Equipment Utilized:
EMI Receiver: HP 8546A
LISN: EMCO 3816/2NM
Transient Limiter: HP 119474A

		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBµV/m)	Q-Peak Limit (dBµ V/m)	Quasi-Peak Margin (dB)	Average Reading (dBµV/m)	Average Limit (dBµ V/m)	Average Margin (dB)
0.155	L1	42.9	66.0	23.1	29.0	56.0	27.0
0.285	L1	28.8	60.7	31.9	23.0	50.7	27.7
0.428	L1	23.6	57.3	33.7	20.2	47.3	27.1
0.568	L1	22.9	56.0	33.1	16.0	46.0	30.0
0.711	L1	26.9	56.0	29.1	20.1	46.0	25.9
2.421	L1	21.5	56.0	34.5	10.7	46.0	35.3
0.155	L2	41.4	66.0	24.6	31.2	56.0	24.8
0.285	L2	28.3	60.7	32.4	22.9	50.7	27.8
0.428	L2	24.6	57.3	32.7	21.4	47.3	25.9
0.572	L2	14.8	56.0	41.2	12.2	46.0	33.8
0.716	L2	24.5	56.0	31.5	18.2	46.0	27.8
0.861	L2	25.2	56.0	30.8	17.5	46.0	28.5

Notes:

1) All other emissions were better than 20 dB below the limits.

2) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.

3) All three configurations exhibited similar emissions.

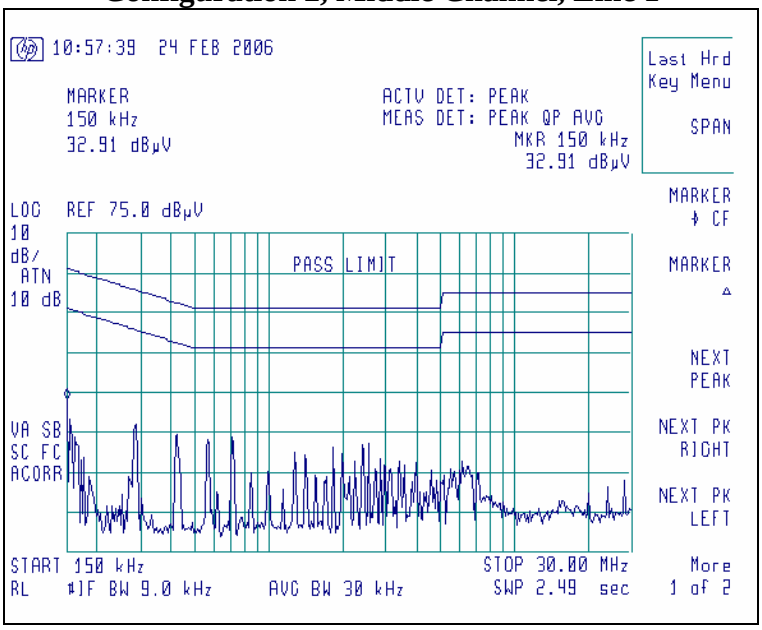
Setup for the Conducted Emissions Test

Screen Captures of Conducted AC Mains Emissions:

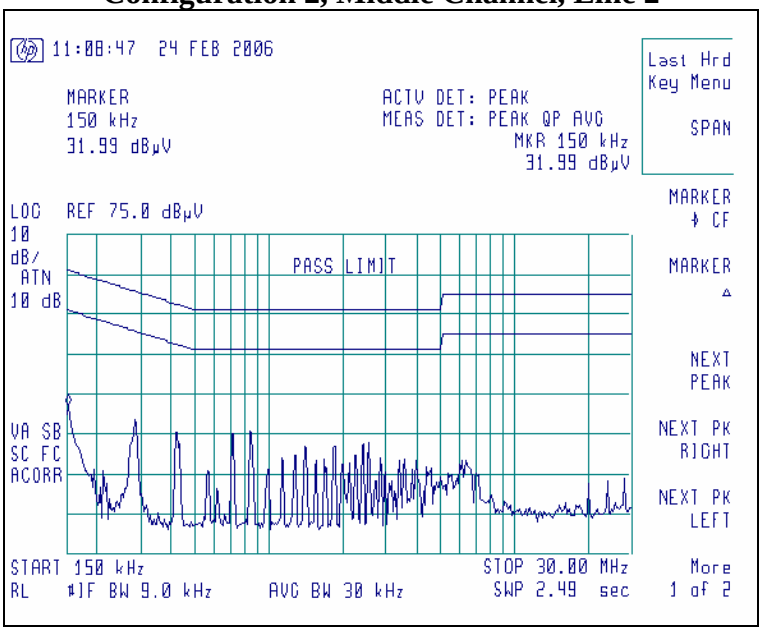
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207.

The signature scans shown here are from the middle channel, chosen as being a good representative of channels.

Configuration 2, Middle Channel, Line 1



Configuration 2, Middle Channel, Line 2



11. Occupied Bandwidth

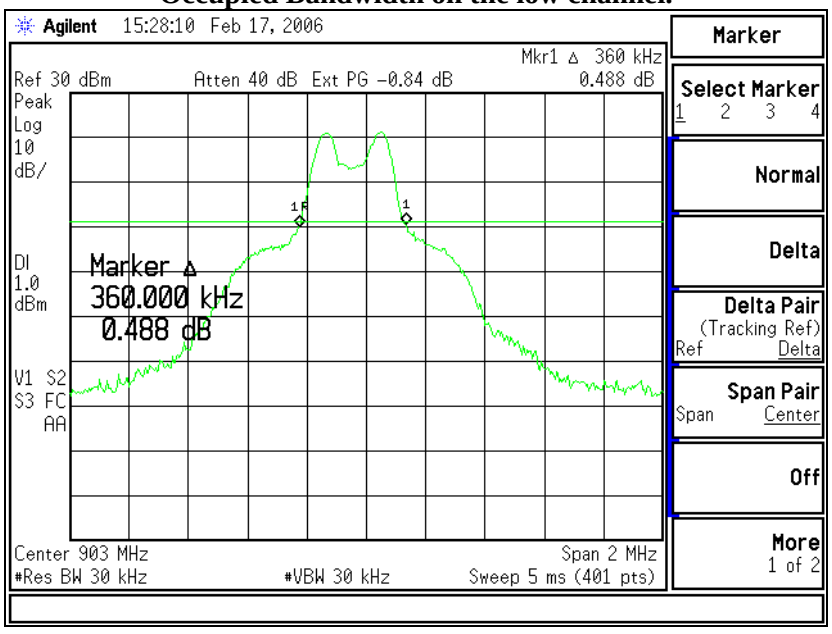
The 20 dB bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. For this portion of the tests, a direct conducted measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum analyzer. The loss from the cable was added on the analyzer as gain offset settings, there by allowing direct readings of the measurements without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 30 kHz for this portion of the tests. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

From this data, the closest measurement when compared to the specified limit, is 360 kHz, which is below the maximum limit of 500 kHz. The device also meets the minimum of 25 hopping channels as required by this occupied bandwidth.

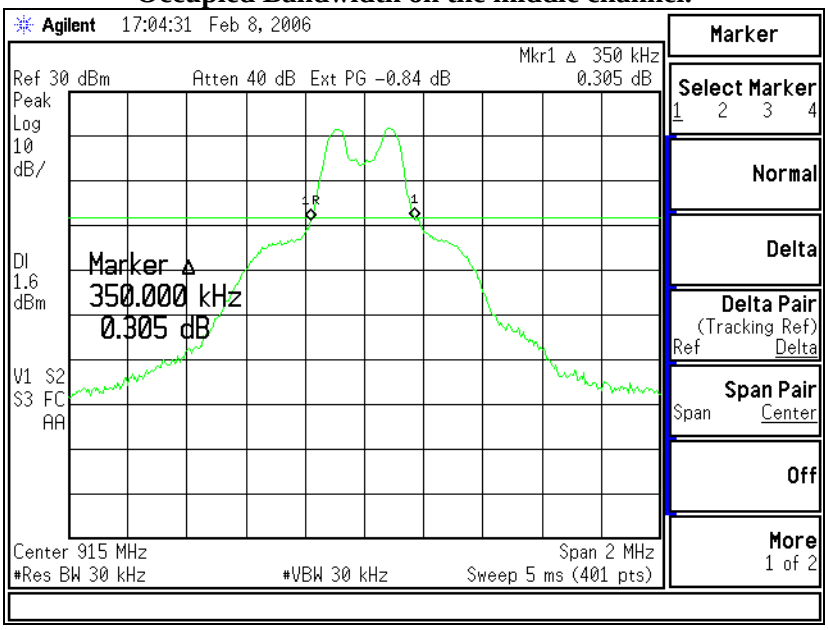
Channel	Center Frequency (MHz)	Measured 20 dB BW (kHz)	Maximum Limit (kHz)
Low	903	360	500
Middle	915	350	500
High	927	345	500

Plots of Occupied Bandwidth

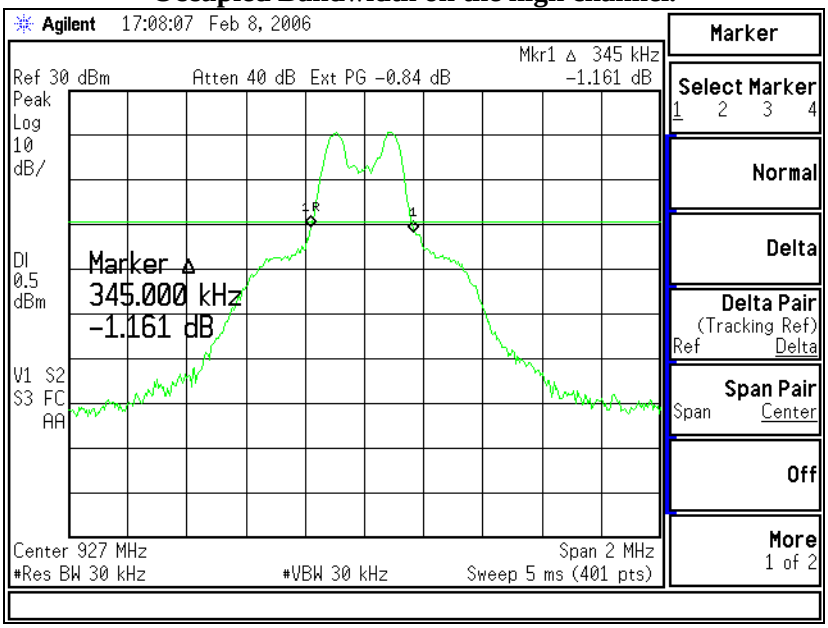
Occupied Bandwidth on the low channel.



Occupied Bandwidth on the middle channel.



Occupied Bandwidth on the high channel.

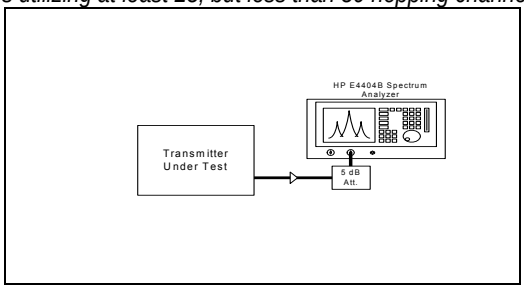


12. Power Output 15.247(b)(2)

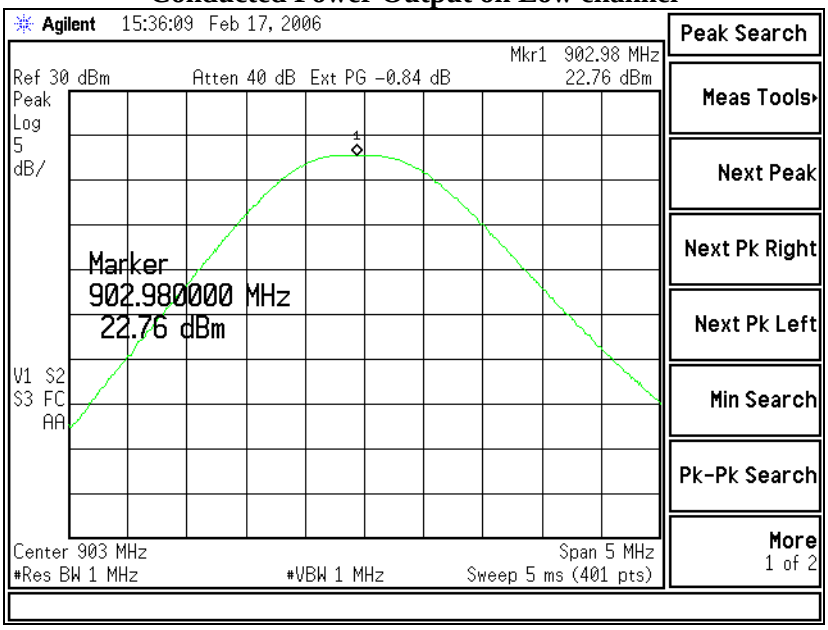
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable to the spectrum analyzer. The loss from the cable was added on the analyzer as gain offset settings, there by allowing direct readings of the measurements made without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 1 MHz, with measurements from a peak detector presented in the chart below.

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
Low	903	+24 dBm	+22.8	1.0
Middle	915	+24 dBm	+ 22.7	1.3
High	927	+24 dBm	+ 22.0	2.0

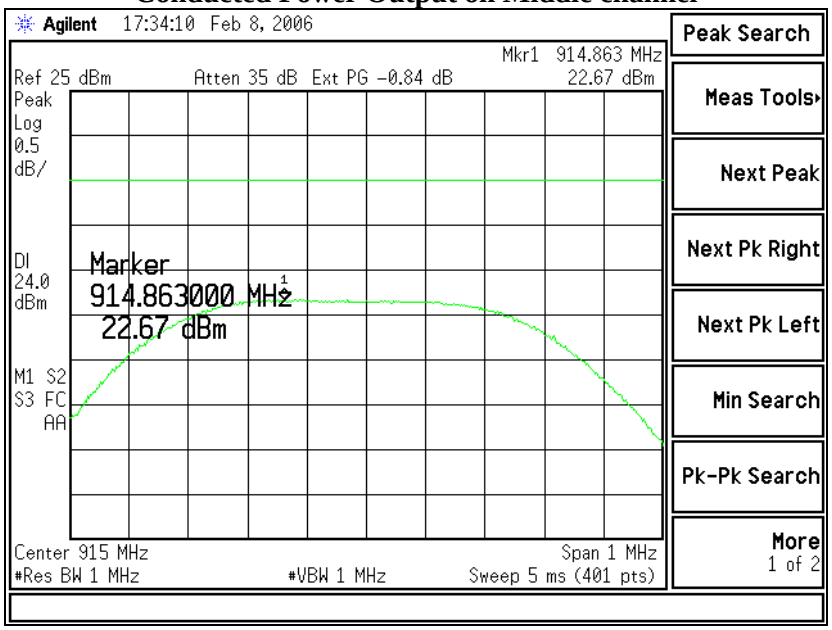
Notes: Limit of + 24 dBm is for systems utilizing at least 25, but less than 50 hopping channels.



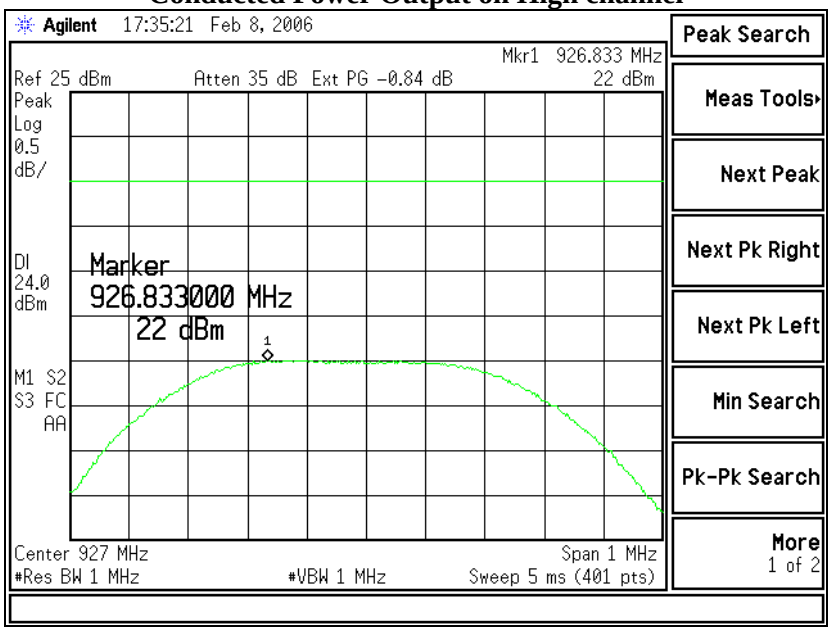
Conducted Power Output on Low channel



Conducted Power Output on Middle channel



Conducted Power Output on High channel



13. Spurious Emissions 15.247(d)

FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable with a spectrum analyzer. The loss from the cable was added on the analyzer as gain offset settings, there by allowing direct readings of the measurements made without the need for any further corrections. A Hewlett Packard model E4407B spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

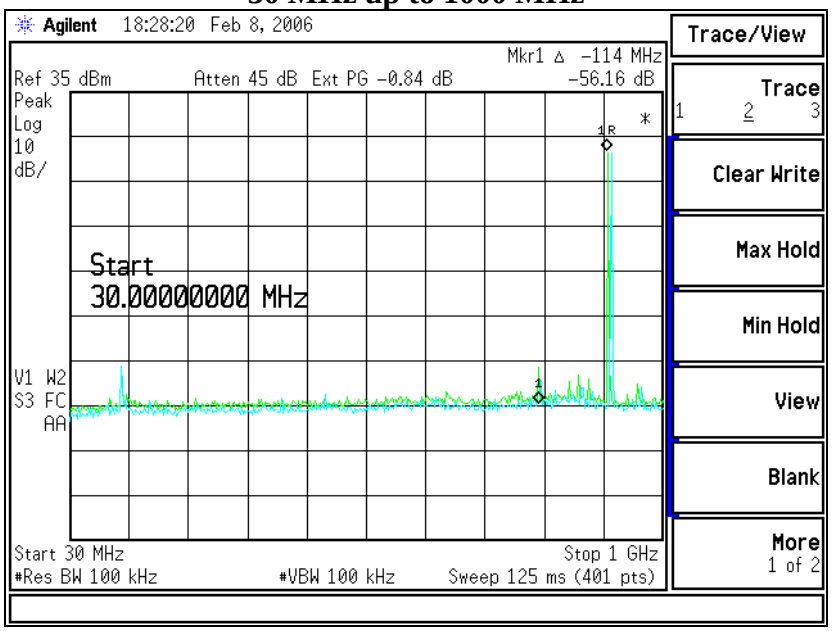
No significant emissions could be noted within -40 dBc of the fundamental level for this product.

	Low Channel	Middle Channel	High Channel	Limit
115-117 MHz	- 26.6 (dBm)	- 26.2 (dBm)	- 24.7 (dBm)	- 20 dBc
795-812 MHz	- 25.4 (dBm)	- 24.7 (dBm)	- 24.3 (dBm)	- 20 dBc
862 MHz	- 27.2 (dBm)	Note (1)	Note (1)	- 20 dBc
957 MHz	- 28.6 (dBm)	Note (1)	Note (1)	- 20 dBc
1020-1045 MHz	- 33.8 (dBm)	- 27.4 (dBm)	- 27.3 (dBm)	- 20 dBc
Fundamental	+ 21.9 (dBm)	+ 21.5 (dBm)	+ 20.09 (dBm)	Reference
2nd Harmonic	- 39.7 (dBm)	- 54.4 (dBm)	- 50.5 (dBm)	- 20 dBc
3rd Harmonic	- 77.2 (dBm)	- 77.7 (dBm)	- 82.3 (dBm)	- 20 dBc
4th Harmonic	- 78.5 (dBm)	- 77.7 (dBm)	- 82.2 (dBm)	- 20 dBc
5th Harmonic	- 79.1 (dBm)	- 79.8 (dBm)	- 81.1 (dBm)	- 20 dBc
6th Harmonic	- 79.0 (dBm)	- 79.2 (dBm)	- 77.8 (dBm)	- 20 dBc
7th Harmonic	- 78.7 (dBm)	- 79.2 (dBm)	- 80.9 (dBm)	- 20 dBc
8th Harmonic	- 71.2 (dBm)	- 71.4 (dBm)	- 60.8 (dBm)	- 20 dBc
9th Harmonic	- 73.4 (dBm)	- 73.7 (dBm)	- 70.5 (dBm)	- 20 dBc
10th Harmonic	- 71.4 (dBm)	- 73.0 (dBm)	- 61.5 (dBm)	- 20 dBc

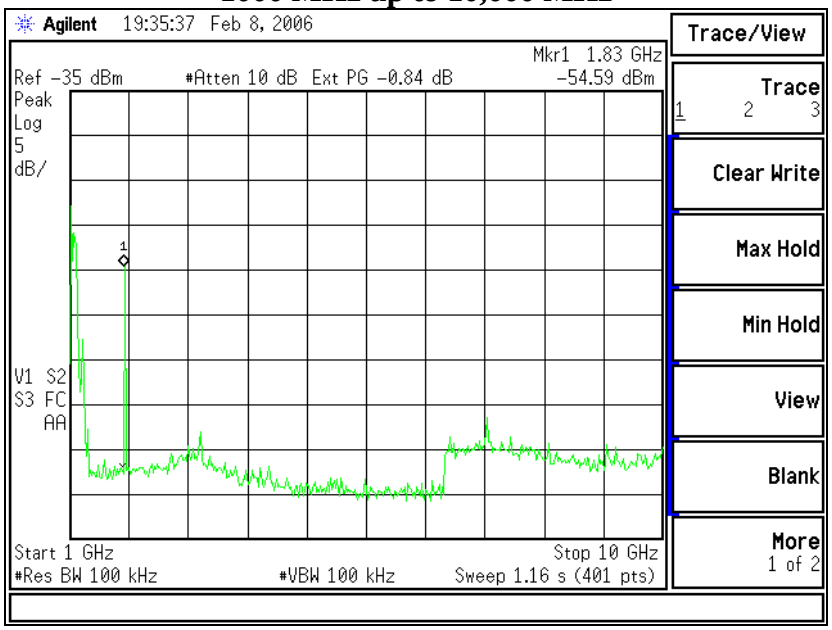
Notes:
(1) Measurement at system noise floor.

The wide screen captures show spurious emissions as measured at the RF port. The actual measurements were made with 500 kHz span on the spectrum analyzer.
The middle channel is chosen as a good representative of all channels.

30 MHz up to 1000 MHz



1000 MHz up to 10,000 MHz



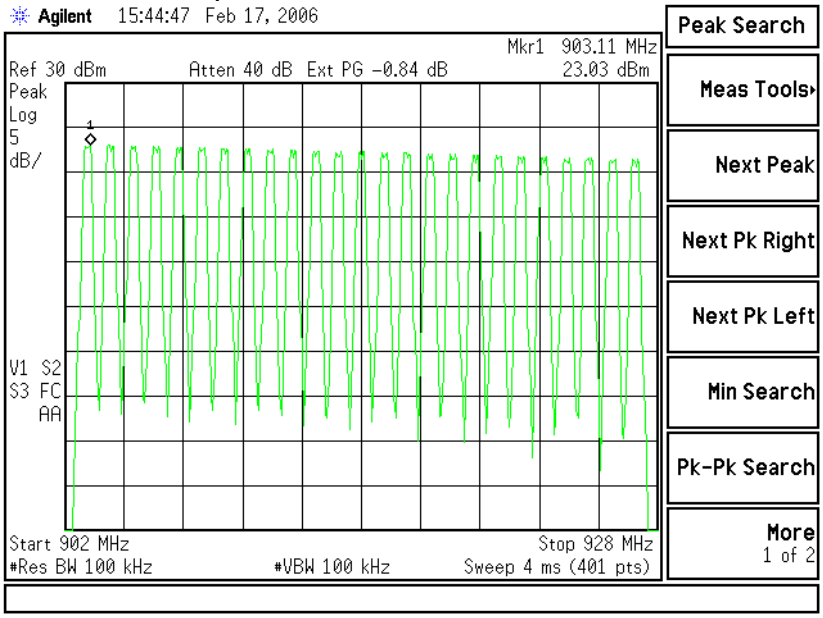
14. Minimum Channel Separation

Part 15.247(a)(1) requires a minimum channel separation of 25 kHz or the equivalent of the 20 dB occupied bandwidth of the fundamental transmission, whichever is greater. An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The channel-separation measured for this device is 1 MHz. The maximum occupied bandwidth of the device, as reported in the previous section is 360 kHz. The minimum channel separation for the EUT exceeds both the 25 kHz criteria and the 20 dB occupied bandwidth criteria, and hence meets the requirements. By having an occupied bandwidth greater than 250 kHz, the system must utilize at least 25 hopping channels. The following plots describe this spacing, and also establish the number of hop channels at a total of 25.

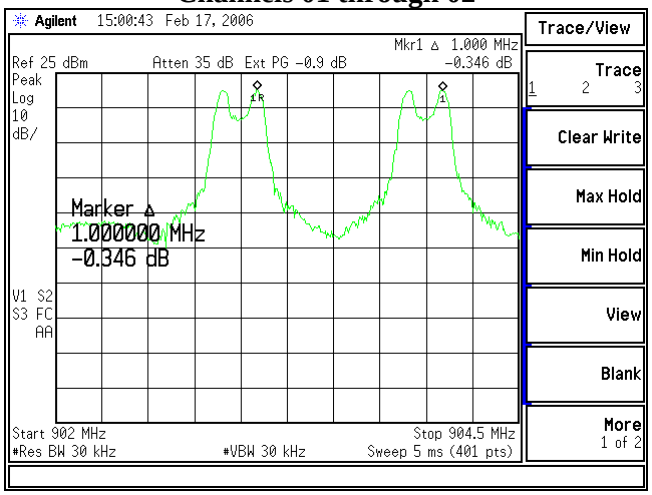
Frequency Span	Number of Channels	Minimum Separation
902.0 – 904.5 MHz	2	1.0 MHz
904.5 – 907.5 MHz	3	1.0 MHz
907.5 – 910.5 MHz	3	1.0 MHz
910.5 – 913.5 MHz	3	1.0 MHz
913.5 – 916.5 MHz	3	1.0 MHz
916.5 – 919.5 MHz	3	1.0 MHz
919.5 – 922.5 MHz	3	1.0 MHz
922.5 – 925.5 MHz	3	1.0 MHz
925.5 – 928.5 MHz	2	1.0 MHz

Hop Mode verification of 25 channels

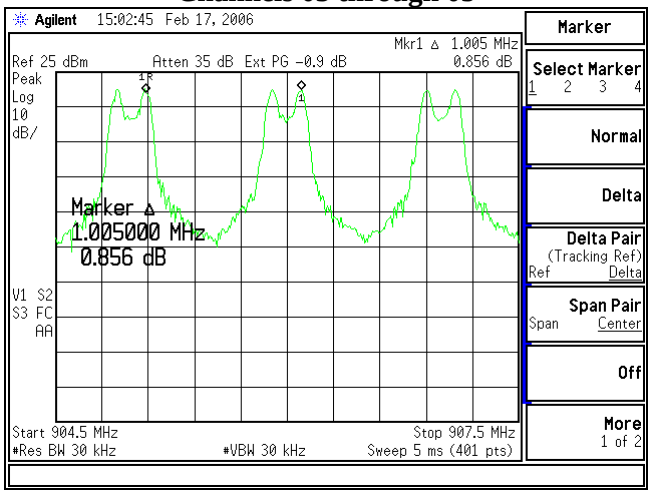


Plots of Channel Separations

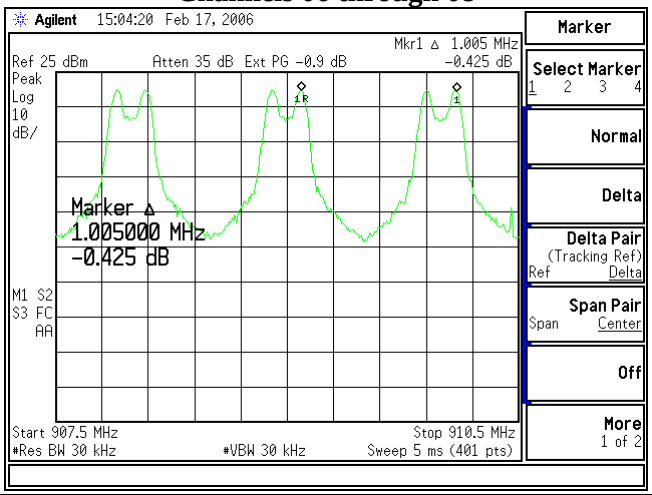
Channels 01 through 02



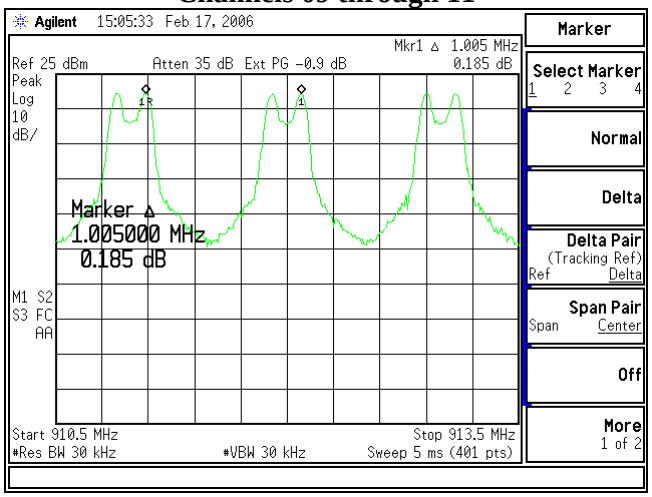
Channels 03 through 05



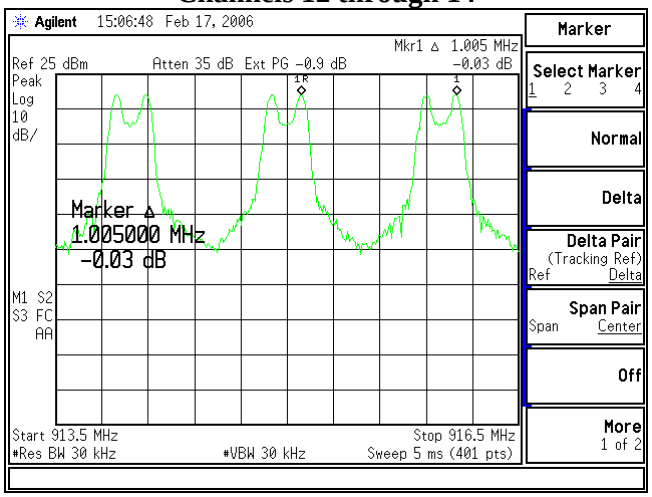
Channels 06 through 08



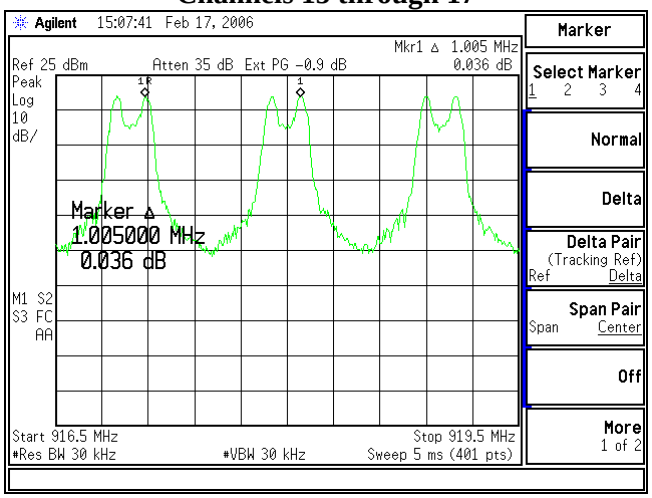
Channels 09 through 11



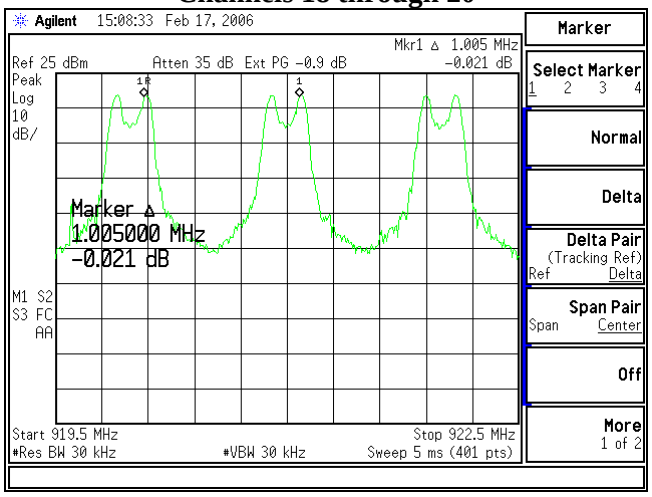
Channels 12 through 14



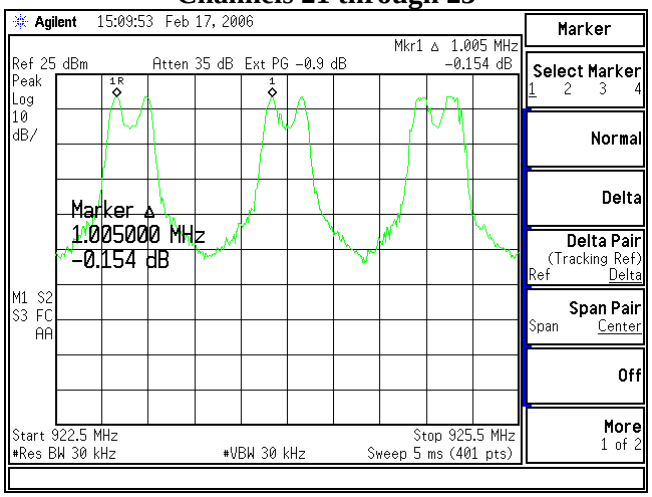
Channels 15 through 17



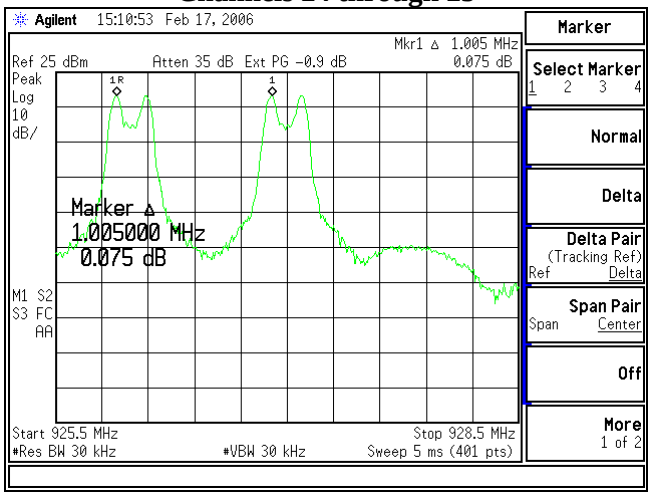
Channels 18 through 20



Channels 21 through 23



Channels 24 through 25



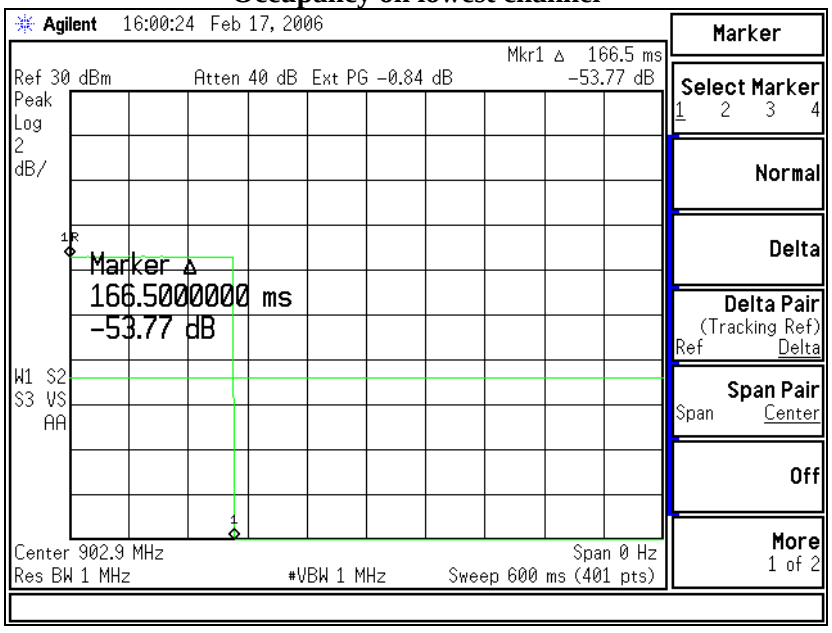
15. Channel Occupancy

Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 10 second window. The channel occupancy for this EUT was measured using an HP E4407B spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths can be measured by adjusting the sweep rate of the analyzer. A suitable sweep rate was used to measure the channel occupancy at the low, mid and high channels. The longest time any transmission will occur on a single channel is 166.5 ms. With a total of 25 channels used, each occupying a 166.5 ms slot, it will take 4.163 seconds for the sequence to repeat. In a 10 second window, each channel would have 2.4 transmission cycles. The maximum occupancy in a 10 second window is calculated by multiplying the 2.40 transmission cycles by 166.5 ms transmission duration per cycle, to arrive at 399.6 ms total occupancy.

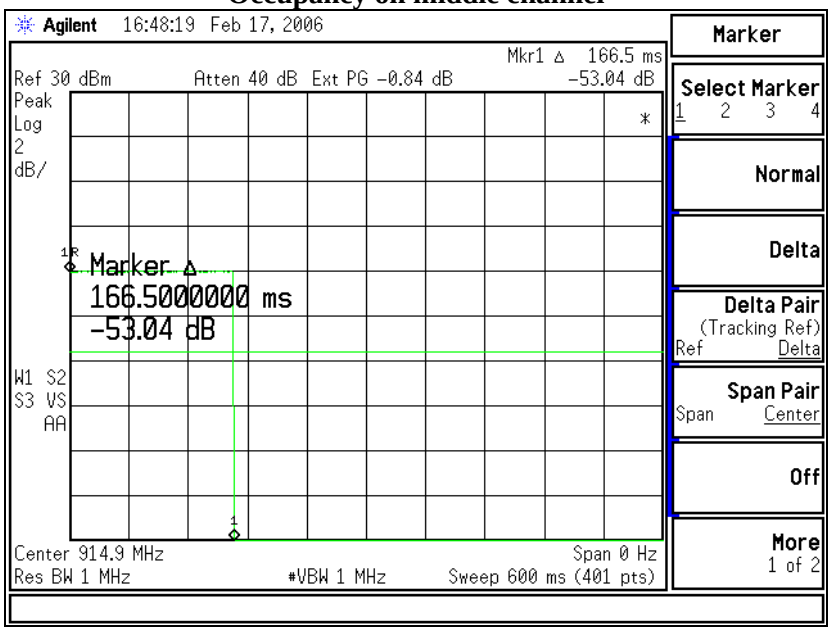
Channel	Frequency (MHz)	Occupancy Per transmission (ms)	Occupancy in 10s window (ms)
Low	903	166.5	399.6
Middle	915	166.5	399.6
High	927	166.5	399.6

Plots of Channel Occupancy

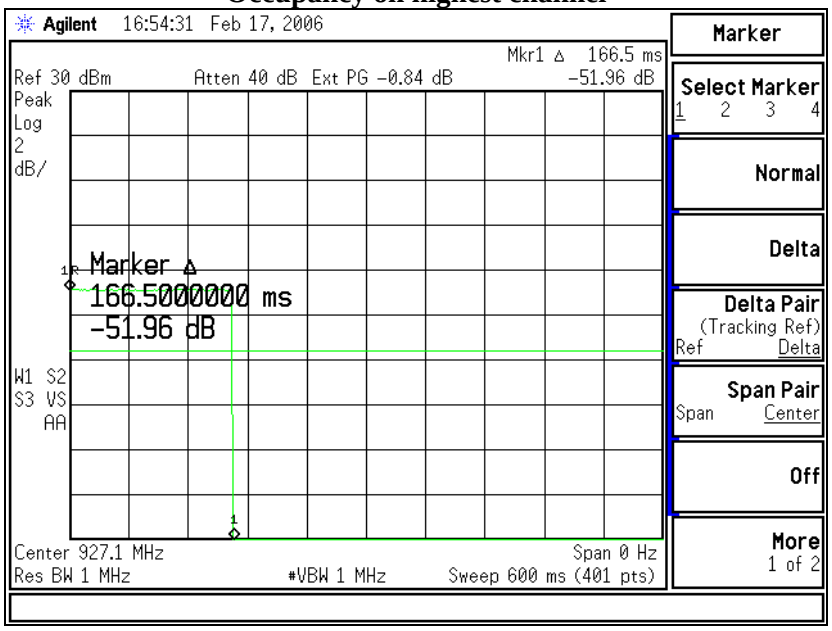
Occupancy on lowest channel



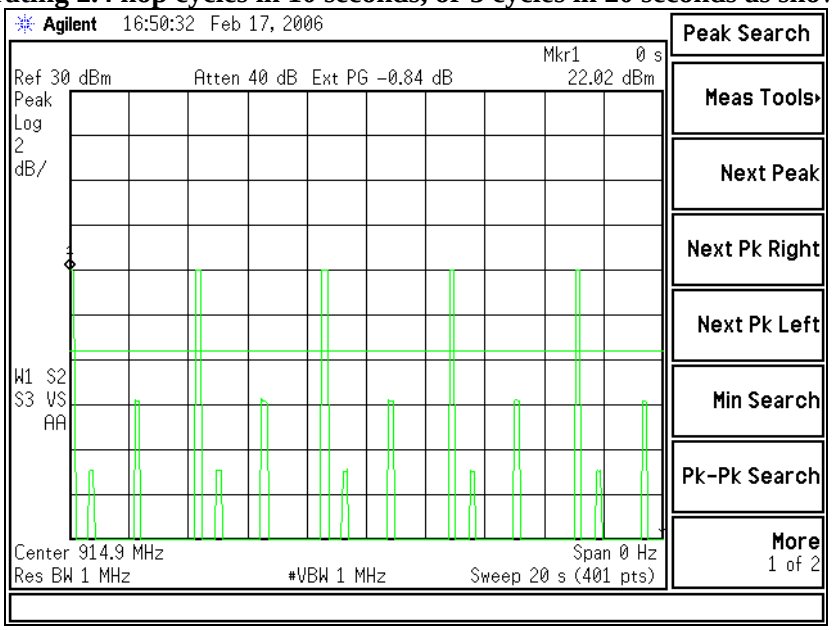
Occupancy on middle channel



Occupancy on highest channel



Occupancy on middle channel in a 20 second window,
demonstrating 2.4 hop cycles in 10 seconds, or 5 cycles in 20 seconds as shown below.



16. Frequency and Power Stability requirements

For this portion of the tests, a spectrum analyzer was used to measure the frequency at the appropriate frequency markers, with the transmitter portion of the EUT placed in modulated continuous transmit mode for the power measurements, and CW mode for the frequency measurements. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer

. The output power was measured with a receiver resolution bandwidth of 1 MHz, and video bandwidth of 1 MHz.

	DC Voltage Source		
	2.80 V	3.30 V	3.80 V
Low Channel	+ 21.5 (dBm)	+ 22.8 (dBm)	+ 24.0 (dBm)
Mid Channel	+ 21.1 (dBm)	+ 22.7 (dBm)	+ 23.7 (dBm)
High Channel	+ 20.3 (dBm)	+ 22.0 (dBm)	+ 23.0 (dBm)

. The frequency was measured with a receiver resolution bandwidth of 1 kHz, and video bandwidth of 1 kHz.

	DC Voltage Source		
	2.80 V	3.30 V	3.80 V
Low Channel	902.99700 (MHz)	902.99650 (MHz)	902.99650 (MHz)
Mid Channel	914.99730 (MHz)	914.99750 (MHz)	914.99730 (MHz)
High Channel	926.99755 (MHz)	926.99700 (MHz)	926.99710 (MHz)

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.

No anomalies were noted, in the measured transmit power, varying -1.7/+1.2 dB, during the voltage variation tests.

The information on this page is provided by the manufacturer.

17. Equal Channel Usage

The 25 channels are arrayed in a table which the system uses to determine the next hopping channel. Each time a transmission is made the system uses the next frequency in the table. The table is started over once the end has been reached. Thus, any given frequency will not be reused until all other frequencies have been accessed. This also addresses part 15.247(g) concerns.

18. Pseudorandom Hopping Pattern

The hopping patterns were chosen to maintain uniform usage of the spectrum, while maintaining the pseudorandom nature of the channels. The Frequency hopping table is defined in this chart:

Frequency Order	Frequency (MHz)
1	910
2	919
3	911
4	918
5	912
6	907
7	904
8	903
9	905
10	913
11	906
12	915
13	920

Frequency Order	Frequency (MHz)
14	927
15	923
16	916
17	909
18	908
19	917
20	922
21	925
22	921
23	926
24	924
25	914

The information on this page is provided by the manufacturer.

19. Receiver Synchronization

The module uses 25 frequencies for hopping, separated by 1 MHz from each other in a pseudorandom sequence. It dwells on each frequency listed in the frequency hopping table for a nominal period of 170 milli-seconds.

Whenever synchronization is required, a Slave hops at the frequencies listed in the table, but in "reversed" sequential order, while the Master always hops through a forward progressing sequential order.

At each frequency, the slave sends a beacon request.

If after hopping throughout the 25 frequencies, the Slave does not receive a beacon acknowledge, it dwells for a nominal duration of 85 ms on the first frequency only, and then continues hopping in the "reversed" sequence in 170 ms intervals.

When the two modules' frequencies coincide, the Master sends a beacon acknowledge.

Once the Slave receives that beacon acknowledge, it will change the direction of frequency hopping to a forward sequential type, following the same sequence the Master hops.

20. Receiver Input Bandwidth

The EUT receiver section has a bandwidth of 200 kHz. There are two filters in the receiver path, a 230 kHz 3^{RD} order Sallen-Key preceding a 6-pole elliptical switched capacitor LPF at 200 kHz.

The module uses 25 frequencies for hopping, separated by 1 MHz from each other in a pseudorandom sequence. It dwells on each frequency listed in the frequency hopping table for a nominal period of 170 milli-seconds.

21. MPE Calculations

900 MHz Transceiver Module
MPE Calculation based on the highest gain antenna configuration

Configuration	Antenna MFG	Model	Gain
1	Antenna Factor	ANT-916-CW-RH	2.5 dBi
2	Antenna Factor	ANT-916-MHW-RPS	2.0 dBi
3	"Generic Wire Whip"	8 cm long, 22 AWG	4.1 dBi (Note 1)

Notes:
1) The antenna gain was calculated based on empirical electric field intensity measurements above a conductive ground plane. The antenna gain figure listed is not free-space antenna gain.

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	22.80	(dBm)
Maximum peak output power at antenna input terminal:	190.546	(mW)
Antenna gain(typical):	4.1	(dBi)
Maximum antenna gain:	2.570	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	915	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.62	(mW/cm^2)

Power density at prediction frequency:	0.097438	(mW/cm^2)
Maximum allowable antenna gain:	12.1	(dBi)
Margin of Compliance at 20 cm =	8.0	dB

Appendix A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	9/27/05	9/27/06
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/27/05	9/27/06
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/27/05	9/27/06
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/07/05	12/07/06
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	12/29/05	12/29/06
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/29/05	9/29/06
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/29/05	9/29/06
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	Note 1	Note 1
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	Note 1	Note 1
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	Note 1	Note 1

Note 1 - Equipment calibrated within a traceable system.

Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V

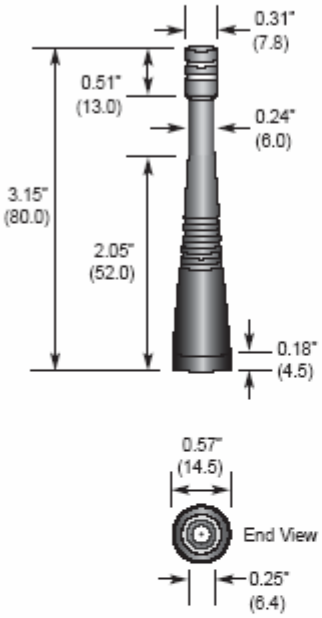
Appendix B

Antenna Specification
Antenna Configuration 1

ANTENNA FACTOR

ANT-916-CW-QW DATA SHEET

Product Dimensions



Description

CW Series 1/4-wave antennas deliver outstanding performance in a rugged and cosmetically attractive package. These antennas feature an SMA or FCC Part 15 compliant RP-SMA connector. This simplifies packaging and shipment, allowing for easy field replacement while complying with FCC requirements. A wide variety of matching connectors allows numerous mounting options. The CW Series comes standard in black, but custom colors are available with a 5,000 piece minimum order.

Features

- Low cost
- Outstanding VSWR
- Excellent performance
- Omni-directional pattern
- Flexible main shaft
- Fully weatherized & damage-resistant
- RP-SMA or SMA connector
- Available in black or custom colors
- Use with plastic* or metal enclosures

* Requires proximity ground plane

Electrical Specifications

Center Freq.	916MHz
Bandwidth	100MHz
Wavelength	1/4-wave
VSWR	<1.9 typ. at center
Impedance	50 ohms
Gain	TBD
Connector	RP-SMA or SMA

Note: Electrical specifications and plots measured on 4"x 4" reference ground plane

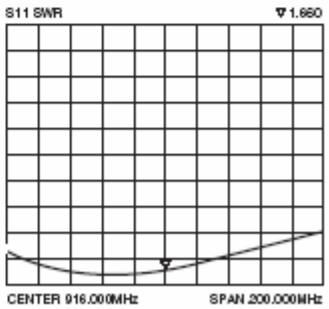
Ordering Information

- ANT-916-CW-QW (with RP-SMA connector)
- ANT-916-CW-QW-SMA (with SMA connector)

Plots

Azimuth

Elevation



Typical VSWR

Antenna Factor 575 S.E. Ashley Place Grants Pass, OR 97526-3237 www.antennafactor.com
541-956-0931 (phone) 541-471-6251 (fax)

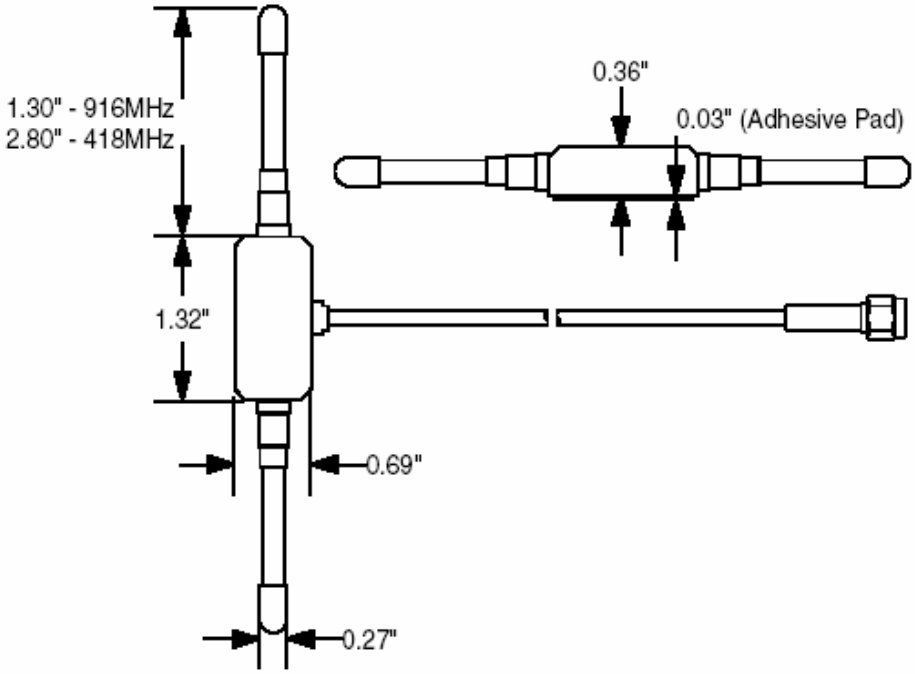
Rev 07-25-05

Antenna Specification

Antenna Configuration 2

ANTENNA FACTOR

SPECIFICATION SHEET
MHW SERIES ANTENNAS



ELECTRICAL SPECIFICATIONS

SPECIFICATION	ANT-418-MHW-RPS	ANT-433-MHW-RPS	ANT-916-MHW-RPS
Frequency Range	410-426	425-441	881-951
Bandwidth	16	16	70
Gain	2dBi	2dBi	2dBi
V.S.W.R.	<1.5	<1.5	<1.5
Impedance	50Ω	50Ω	50Ω
Max Power	50W	50W	50W
Length	6.9"	6.3"	3.9"
Connector	RP-SMA or SMA	RP-SMA or SMA	RP-SMA or SMA
Cable	79" or 15'	79" or 15'	79" or 15'

ORDERING INFORMATION

PART #	DESCRIPTION
ANT-xxx-MHW-***-‡	MHW Series Antenna
xxx = 418, 433 or 916 • *** = RPS (RP-SMA) or SMA ‡ = S (79") or L (15')	

RP-SMA Connector Standard.
Other terminations available for volume orders.

Revised 3/27/03

For additional information, please contact Antenna Factor at 800-489-1634

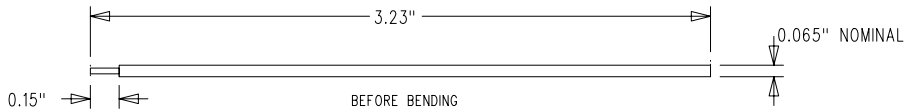
Recipient understands any or all of the above specifications are subject to change without notice and proceeds with integration at own risk.

REVISION RECORD		
REV.	DESCRIPTION:	DATE:
1	FIRST PROTOTYPE RELEASE	8-23-05
2	UPDATED PER ECN-050127-00-1	11-15-05
2.2	UPDATED PER ECN-050127-00-3	3-6-05

NOTES:

1. ALL DIMENSIONS IN INCHES.
2. TOLERANCE - +-.020", UNLESS NOTED OTHERWISE
3. MATERIAL - 20 AWG PVC INSULATED SOLID COPPER HOOK-UP WIRE
   POSSIBLE SOURCES;
   GENERAL CABLE - PART NUMBER C2028 (BLACK)

AFTER BENDING



BEFORE BENDING

HEAT TIMER

FAIRFIELD, NJ

DRAWN BY: DMS	DATE: 8-16-05	TITLE: WIRELESS BOILER CONTROL MODULE - ANTENNA DRAWING		
CHECKED BY:	DATE:	PROJECT: HEAT TIMER #209		
APPROVED BY:	DATE:	SIZE: A	DRAWING NO: 700120-00-3.22	REV: 2.2
PRINT DATE:				
FILENAME: 050127-00-2_2.pcb		SCALE: 1 TO 1	PAGE 1 OF 1	

Appendix C

Firmware and Setup Instructions

The test modes required were programmed via DIP-Switches on a special interface test board, as provided by the manufacturer. The test board also has an RS-232 port for monitoring the programming and communication to the module.