LS Research, LLC
W66 N220 Commerce Court
Cedarburg, WI 53012
262-375-4400 Fax: 262-375-4248

COMPLIANCE TESTING OF:

ATTI MODULE
Model: ASM-000201-04

Prepared For:

Advanced Tracking Technologies, Inc.
Attn.: Mr. Bob Rooney
6001 Savoy Drive
Suite 600
Houston, TX 77036

Test Report Number:

306206 –TX-TCB Rev. 2

Test Dates:

April 3rd – May 18th 2006

Table of Contents

1. LS Research, LLC In Review

LS Research, LLC - 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

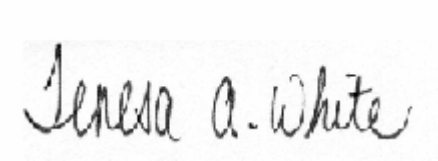
U. S. Conformity Assessment Body (CAB) Validation

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: July 6, 2006

Teresa A. White, Document Coordinator Date

Tested By: July 6, 2006

Abtin Spantman, EMC Engineer Date

Tested By: July 6, 2006

Khairul A. Zainal, EMC Engineer Date

Approved By: **July 6, 2006**

Brian E. Petted, VP of Engineering **Date**

3. Product and General Information

Manufacturer:	Advanced Tracking Technologies, Inc.					
Date(s) of Test:	April 3rd – May 18th , 2006					
Test Engineer(s):	√	Khairul A. Zainal		Abtin Spantman		Ken Boston
Model #:	ASM-000201-04					
Serial #:	05450375					
Voltage:	3.3 VDC					
Operation Mode:	Continuous transmit and 'Hopping' mode					

4. Introduction

Between April 3rd and May 18th, 2006, a series of Conducted and Radiated RF Emission tests were performed on one sample of the Advanced Tracking Technologies, Inc., transceiver Module, Model Number ASM-000201-04, Serial Number 05450375, here forth 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, Annex 8, Section 8.1) for a low power transmitter. These tests were performed by Khairul A. Zainal, EMC Engineer of LS Research, LLC.

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, Annex 8, Section 8.1 for a Frequency Hopping Spread Spectrum Transmitter 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 LS Research, LLC in Cedarburg, Wisconsin, unless otherwise noted.

5. Product Description

The Advanced Tracking Technologies, transceiver Module is a data module designed to operate as a frequency hopper on 52 channels with FSK type modulation in the 902 MHz – 928 MHz ISM band, with a nominal RF output power of 1 Watt. The module operates on 3.3 VDC, 800mA, and transfers data at 76.810 kbps.

During the testing, the EUT was programmed to operate in the desired modes using proprietary software and a laptop PC through an RS-232 link, using a programming fixture board, while being supplied with a 3.3 VDC by means of an external power supply. Supply voltage into the module is regulated by means of on board software, where the transmitter will automatically shut down when supply voltage exceeds **3.5 VDC.** This feature of the module was tested and verified.

The antenna used during testing was an omni-directional Nearson 900 MHz ISM band antenna, model number S152AH-915S. The module is typically equipped with a reverse gender SMA type RF connector. The test sample was provided with a standard SMA connector to facilitate testing, and was fitted with a gender changer during radiated emissions testing to mate with the specified antenna (equipped with reverse gender SMA).

6. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the Advanced Tracking Technologies module with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

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

7. Summary of Test Report

DECLARATION OF CONFORMITY

The Advanced Tracking Technologies Transceiver 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, Annex 8, Section 8.1 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, with modulation from typical data using power as provided by 3.3 VDC 800 mA power as provided by an external D.C. power supply. The unit has the capability to operate on 52 channels, controlled during testing via a laptop PC with proprietary software.

The applicable limits apply at a 3 meter distance. Measurements above 5 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 (902.7 MHz), middle (915.3 MHz) and high (927.2 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using a PC with proprietary software.

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 10 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 an HP8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into an HP8546A EMI receiver database. As a result, the data taken from the HP8546A 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 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 10 Hz).

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, Annex 8, Section 8.1]. 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 1 Watt for systems employing at least 50 hopping channels or 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 100 kHz 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 strength measurement with units of μV/m to dBμV/m would be:

$$dB\mu V/m = 20Log_{10}\left(\frac{XX\mu V/m}{1\mu V/m}\right)$$

Limit in the frequency range of (30-88 MHz) is calculated to be:

$$40.0dB\mu V/m = 20Log_{10}\left(\frac{100\mu V/m}{1\mu V/m}\right)$$

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Sample conversion from a field conducted RF power measurement in mW to a radiated field strength 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 1W (1000mW) 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 125.23 dBμV/m at 3 meters.

$$125.23dB\mu V/m@3m = 95.23 + 10Log_{10}\left(\frac{1000mW}{1mW}\right)$$

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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 10,000 MHz

Manufacturer:	Advanced Tracking Technologies, Inc.					
Date(s) of Test:	April 3rd – May 18th , 2006					
Test Engineer(s):	√	Khairul A. Zainal		Abtin Spantman		Ken Boston
Model #:	n/a					
Serial #:	05450375					
Voltage:	3.3 VDC					
Operation Mode:	Normal, continuous transmit, 'Hopping' mode					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
		Battery	√	Other: Bench D.C. power 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
Log Periodic Antenna: EMCO #93146
Horn Antenna: EMCO #3115
Biconical Antenna: EMCO 93110
Pre-Amp: Advanced Microwave WHA6224
Standard Gain Horn: EMCO 3160-09

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

Frequency (MHz)	Antenna Sense/EUT	Channel /Config.	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
39.5	V/V	27	1.00	0	29.5	105.1	75.6
57.5	V/V	27	1.00	0	31.2	105.1	73.9
80.2	V/V	27	1.00	0	28.7	105.1	76.4
120.1 (Note 2)	V/V	27	1.00	0	30.5	43.5	13.0
184.5	V/V	27	1.00	75	25.5	105.1	79.6
519.6	H/H	00	1.00	269	36.6	105.1	68.5
870.6	H/H	00	1.00	269	44.6	105.1	60.5
896.0	H/H	00	1.00	269	56.0	105.1	49.1
883.4	H/H	00	1.00	269	56.8	105.1	48.3
901.0	H/H	00	1.00	269	77.9	105.1	27.2
928.9	H/H	52	1.00	82	80.3	105.1	24.8
936.5	H/H	52	1.00	82	42.7	105.1	62.4
942.3	H/H	52	1.00	82	49.3	105.1	55.8
951.1	H/H	52	1.00	82	43.4	105.1	61.7
966.4(Note 2)	H/H	52	1.00	82	45.0	54.0	9.0

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) *Frequency resides in restricted band, thus limit is dictated by 15.209.*

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 00:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
902.7	H/H	1.00	284	124.1	125.2	1.1
1805.4	H/S	1.18	49	86.3	105.1	18.8
2708.1 (Note 2)	V/V	1.00	334	53.0	54.0	1.0
3610.8 (Note 2)	H/S	1.13	203	43.8	54.0	10.2
4513.5 (Note 2)	H/S	1.00	0	36.2	54.0	17.8
5416.4 (Note 2)	V/H	1.09	164	51.9	63.5	11.6
6318.9	V/V	1.19	23	72.4	105.1	32.7
7221.6	H/V	1.00	0	54.3	105.1	50.8
8124.3 (Note 2)	V/V	1.00	0	52.9	63.5	10.6
9027.0 (Note 2)	V/V	1.00	0	53.0	63.5	10.5

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 27:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
915.3	H/H	1.00	83	125.1	125.2	0.1
1830.6	H/S	1.14	41	88.4	105.1	16.7
2745.9 (Note 2)	V/V	1.00	104	45.5	54.0	8.5
3661.2 (Note 2)	H/S	1.00	150	39.5	54.0	14.5
4576.5 (Note 2)	H/S	1.00	0	36.2	54.0	17.8
5491.8	V/H	1.18	177	54.9	105.1	50.2
6407.1	V/V	1.19	0	60.0	105.1	45.1
7322.4 (Note 2)	H/V	1.00	0	54.9	63.5	8.6
8237.7 (Note 2)	V/V	1.00	0	53.2	63.5	10.3
9153.0 (Note 2)	V/V	1.00	0	52.9	63.5	10.6

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 52:

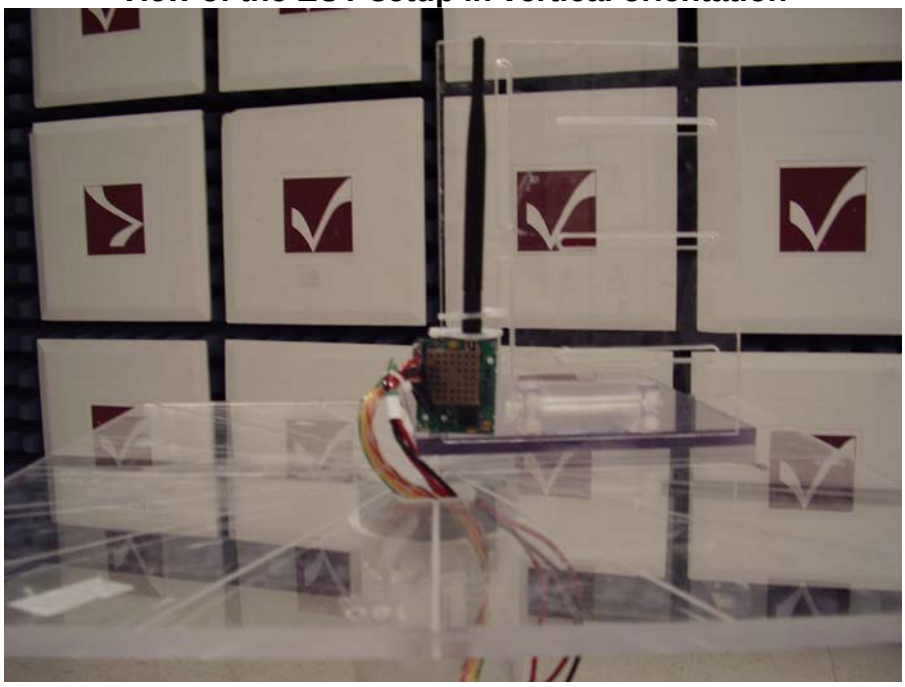
Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927.2	H/H	1.00	82	125.0	125.2	0.2
1854.4	H/S	1.13	47	88.5	105.1	16.6
2781.6 (Note 2)	V/V	1.00	91	52.1	54.0	1.9
3708.8 (Note 2)	H/S	1.51	133	42.5	54.0	11.5
4636.0 (Note 2)	H/S	1.00	0	36.8	54.0	17.2
5563.2	V/H	1.10	163	51.7	105.1	53.4
6490.4	V/V	1.19	10	60.0	105.1	45.1
7417.6 (Note 2)	H/V	1.00	0	54.3	63.5	9.2
8344.8 (Note 2)	V/V	1.00	0	53.2	63.5	10.3
9272.0	V/V	1.00	0	53.6	105.1	51.5

Notes:

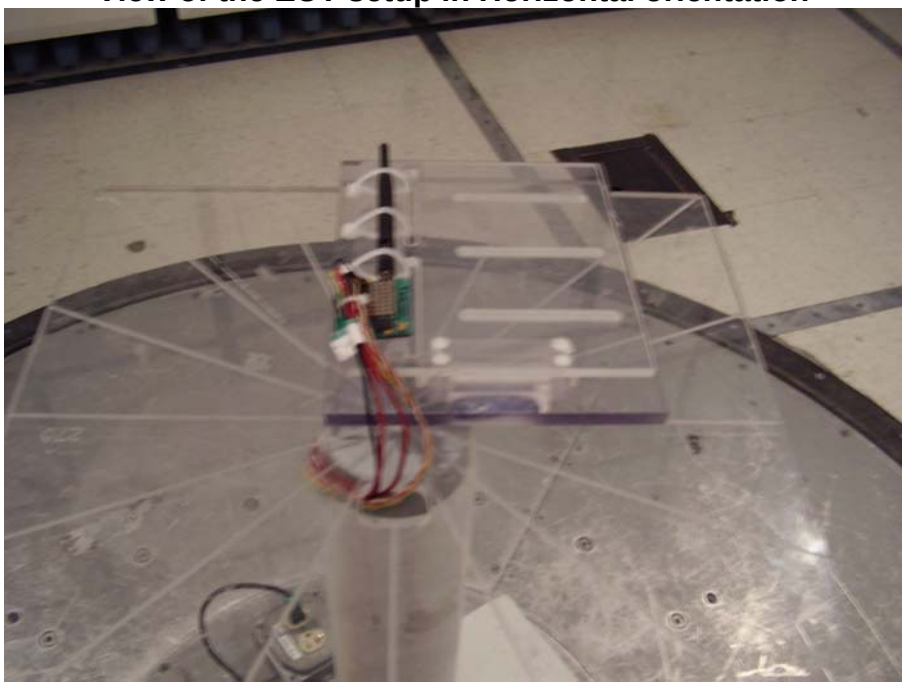
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Only the results from the Average detector are published in the table above. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 1 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation for frequencies above 18 GHz. Frequency resides in restricted band, thus limit is dictated by 15.209.
3) Measurement at receiver system noise floor.

Photos Taken During Radiated Emission Testing

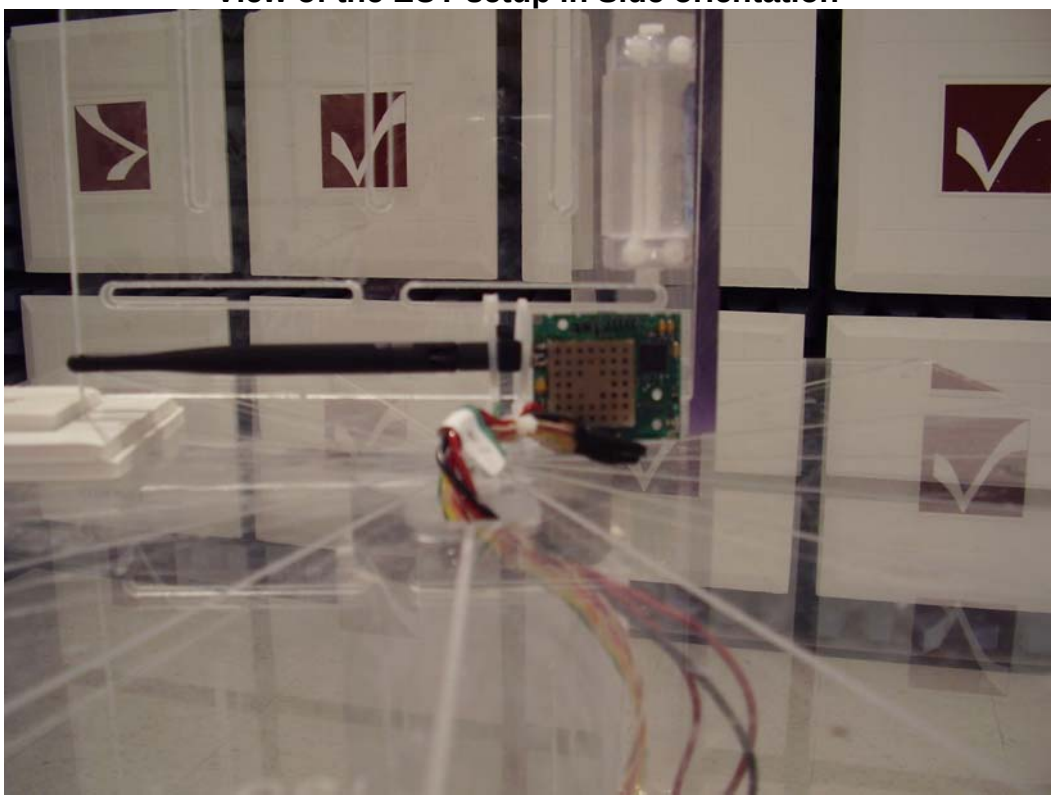
View of the EUT setup in vertical orientation



View of the EUT setup in Horizontal orientation



View of the EUT setup in Side orientation



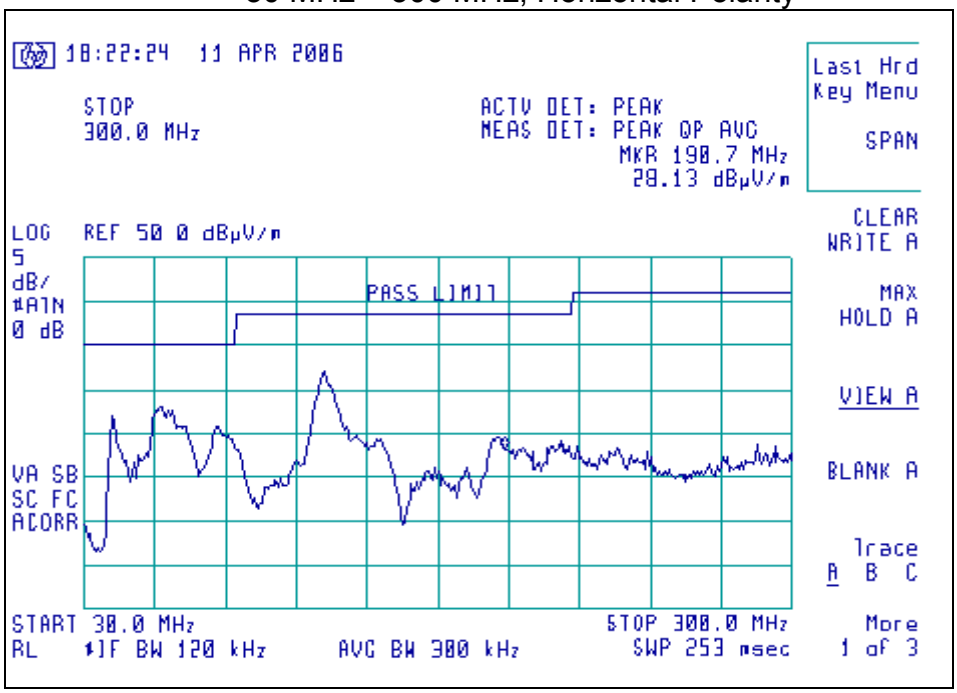
Graphs made during Radiated Emission Testing

Screen Captures of Radiated RF Emissions:

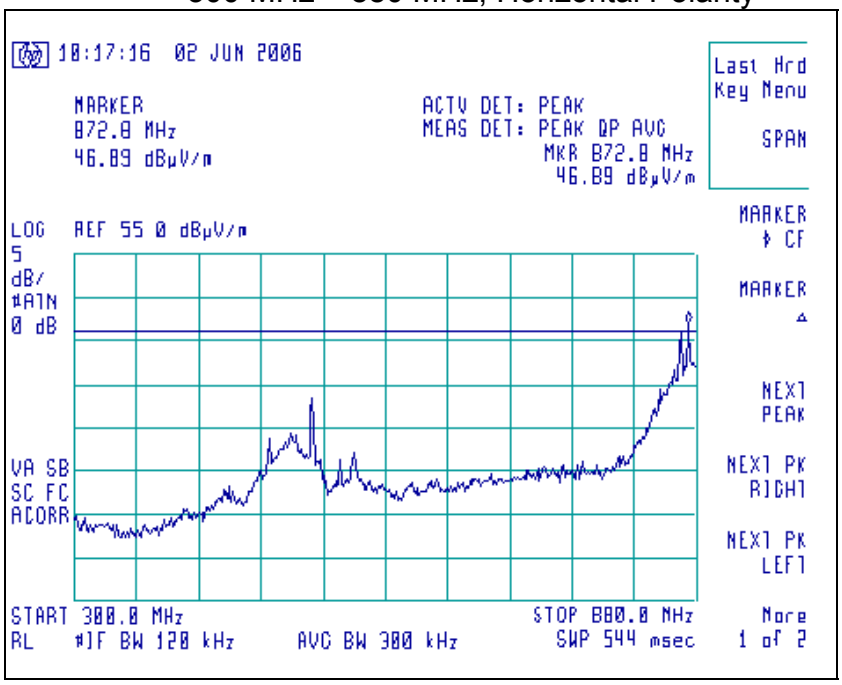
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and an Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 00, 27, or 52.

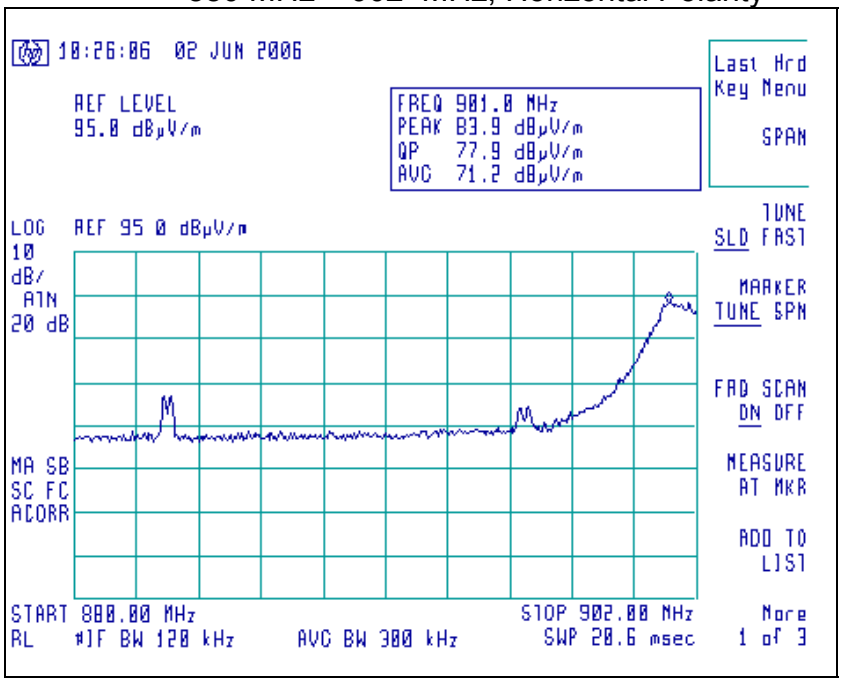
30 MHz – 300 MHz, Horizontal Polarity



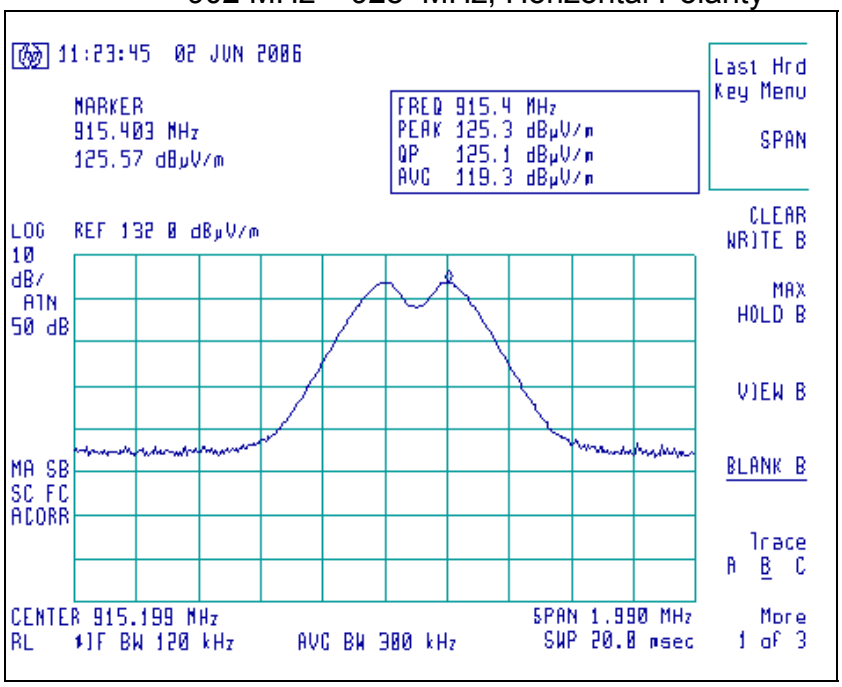
300 MHz – 880 MHz, Horizontal Polarity



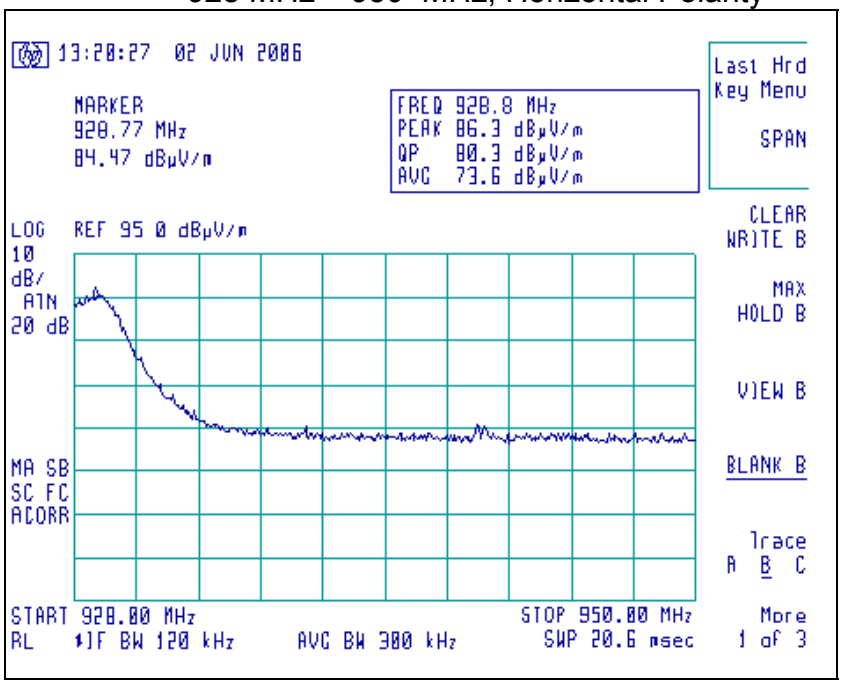
880 MHz – 902 MHz, Horizontal Polarity



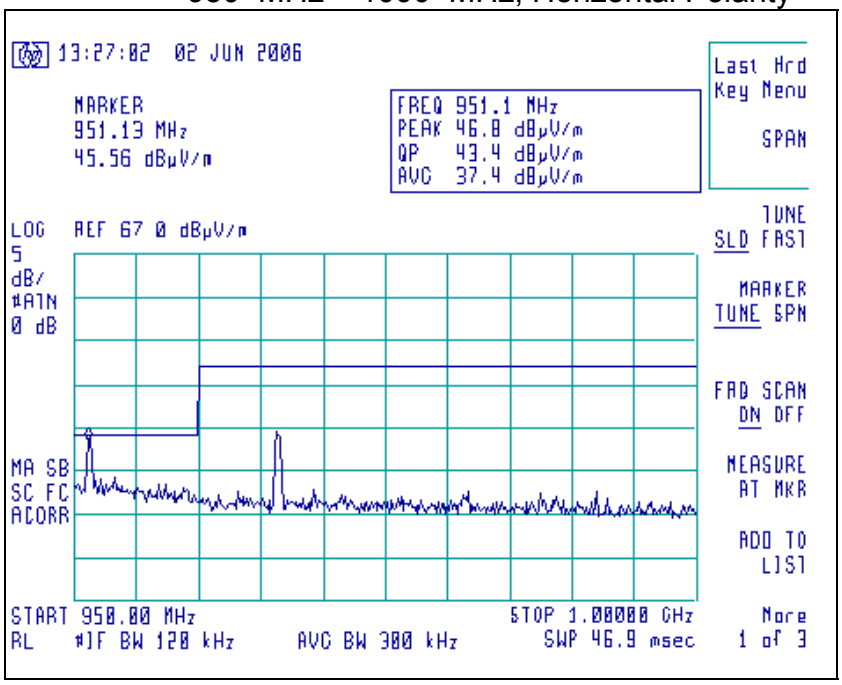
902 MHz – 928 MHz, Horizontal Polarity



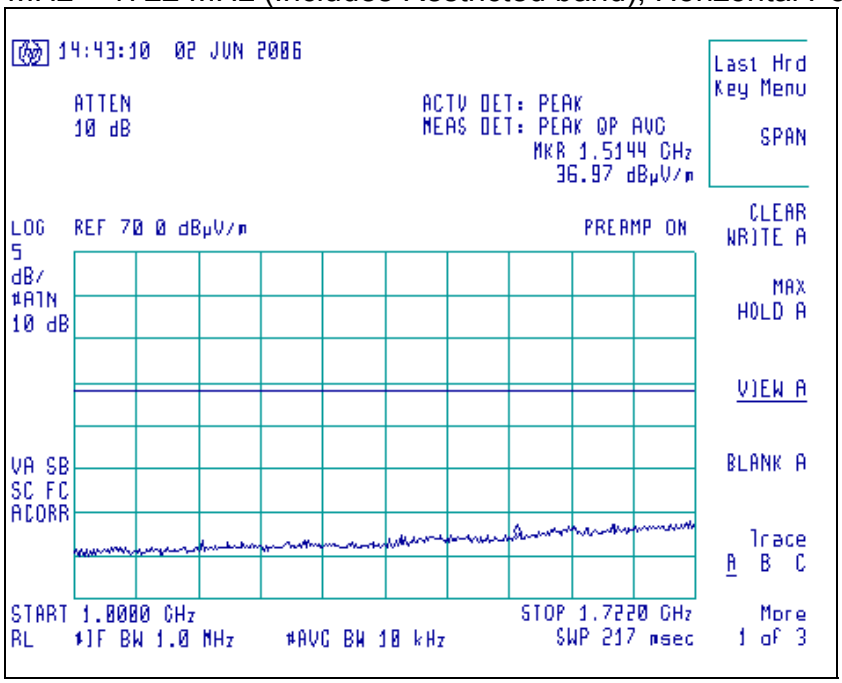
928 MHz – 950 MHz, Horizontal Polarity



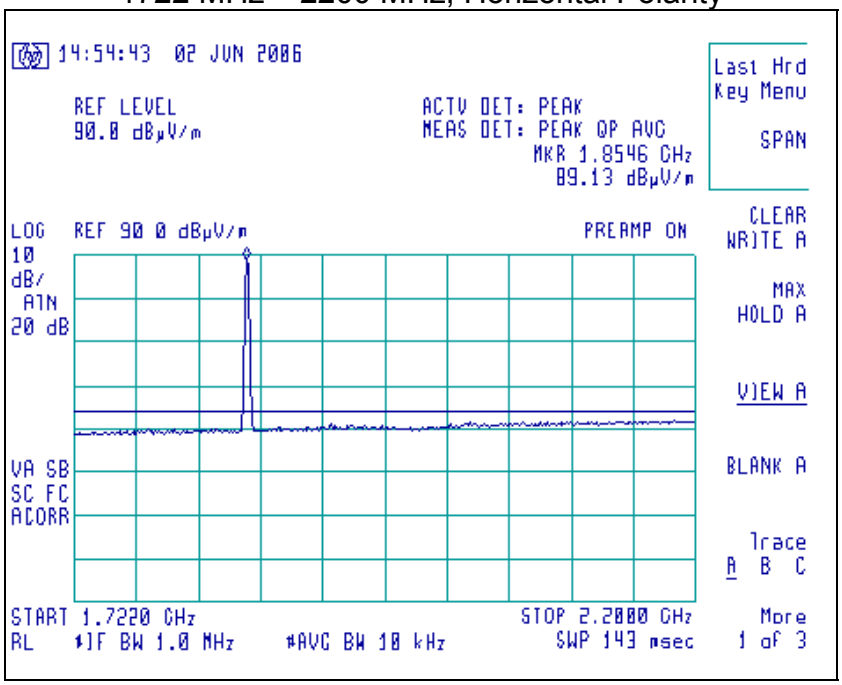
950 MHz – 1000 MHz, Horizontal Polarity



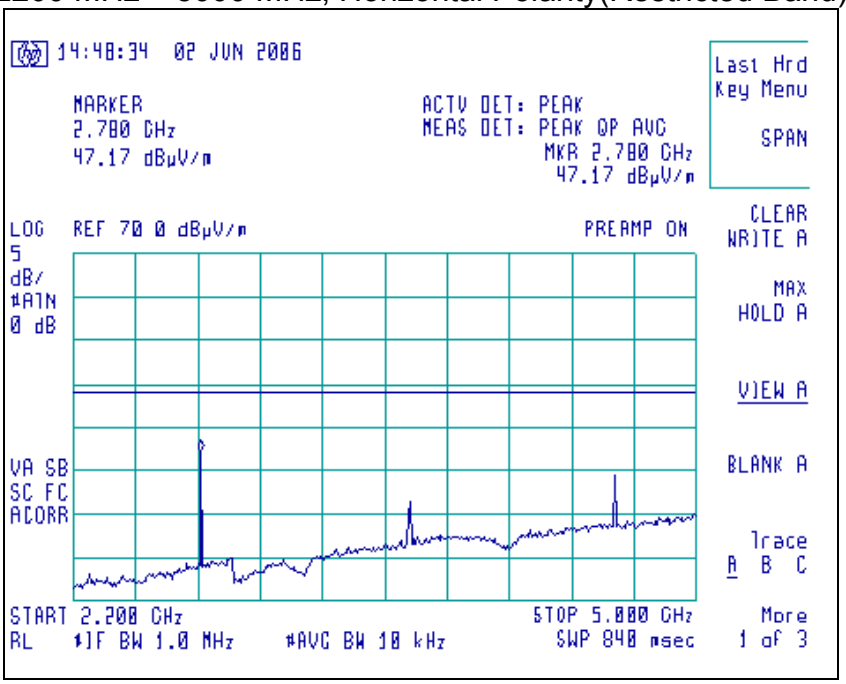
1000 MHz – 1722 MHz (Includes Restricted band), Horizontal Polarity



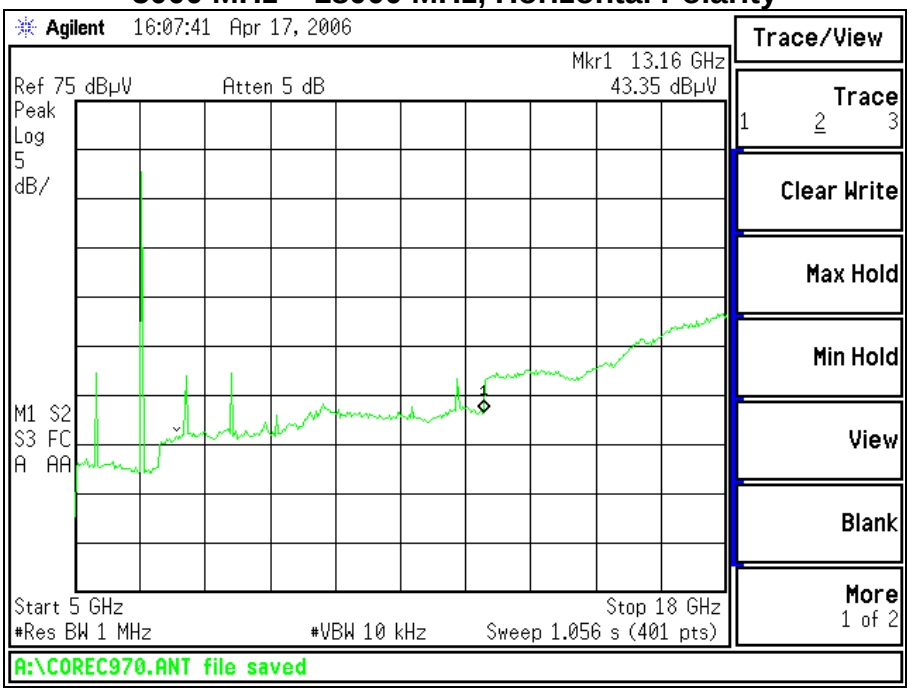
1722 MHz – 2200 MHz, Horizontal Polarity



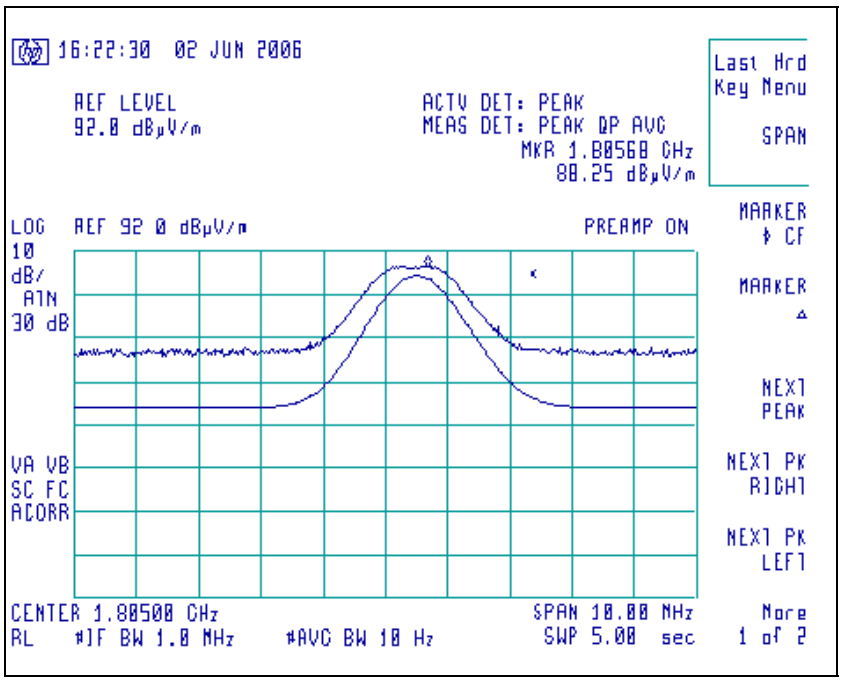
2200 MHz – 5000 MHz, Horizontal Polarity(Restricted Band)



5000 MHz – 18000 MHz, Horizontal Polarity

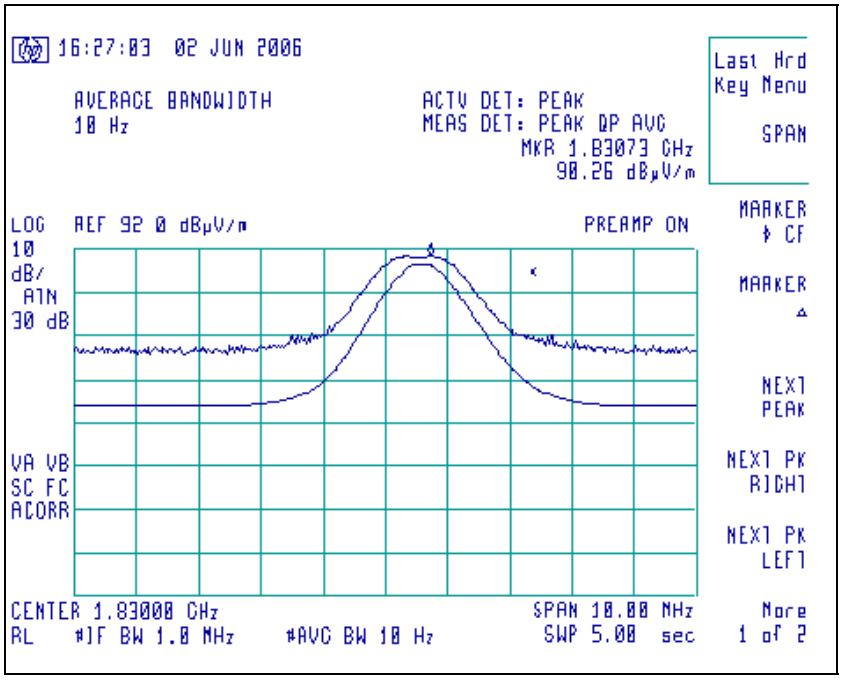


2nd harmonic at Channel 00.

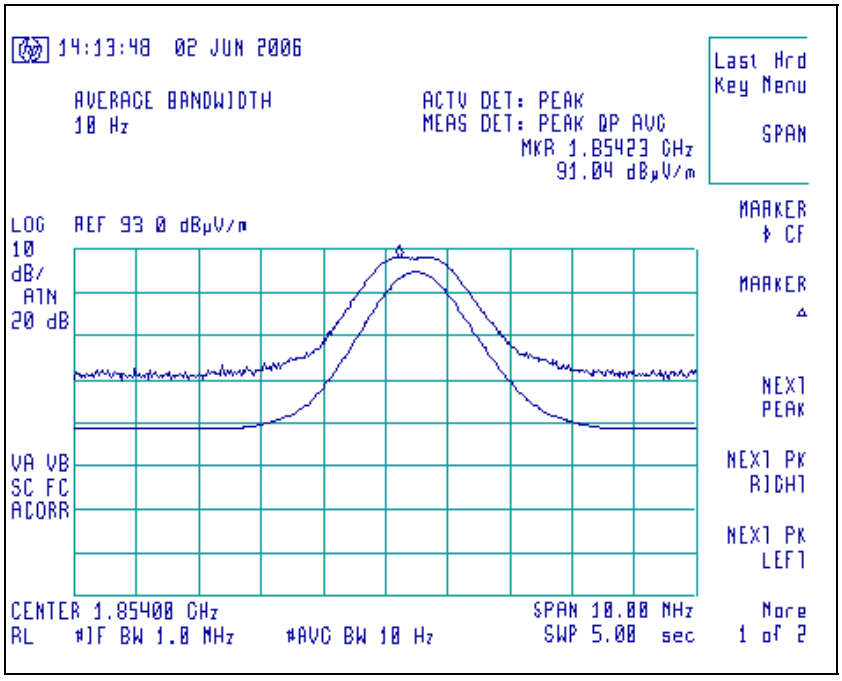


Note: In the plots of the 2nd harmonic, the top trace is peak measurement while the bottom trace is average measurement.

2nd harmonic at Channel 27.



2nd harmonic at the Channel 52.

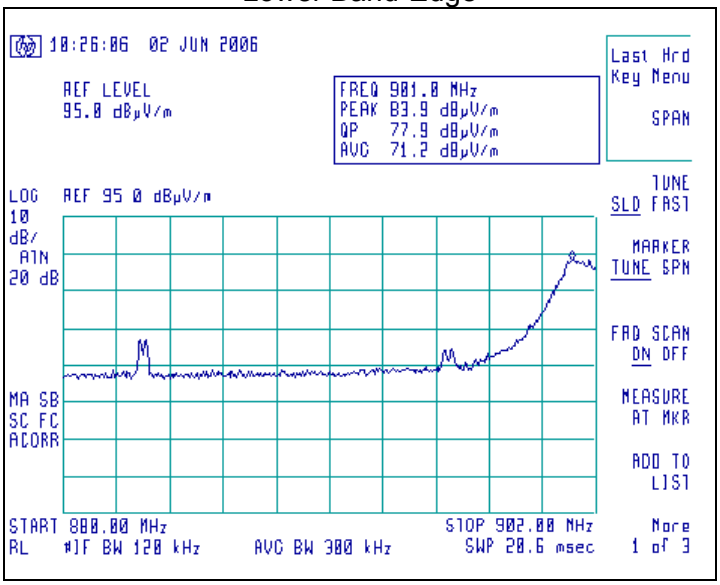


Note: In the plots of the 2nd harmonic, the top trace is peak measurement while the bottom trace is average measurement.

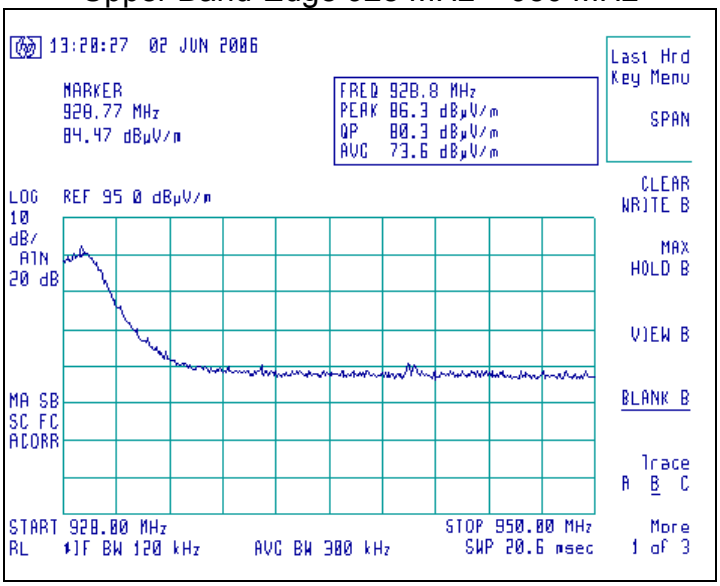
9. Band-Edge Measurements

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.

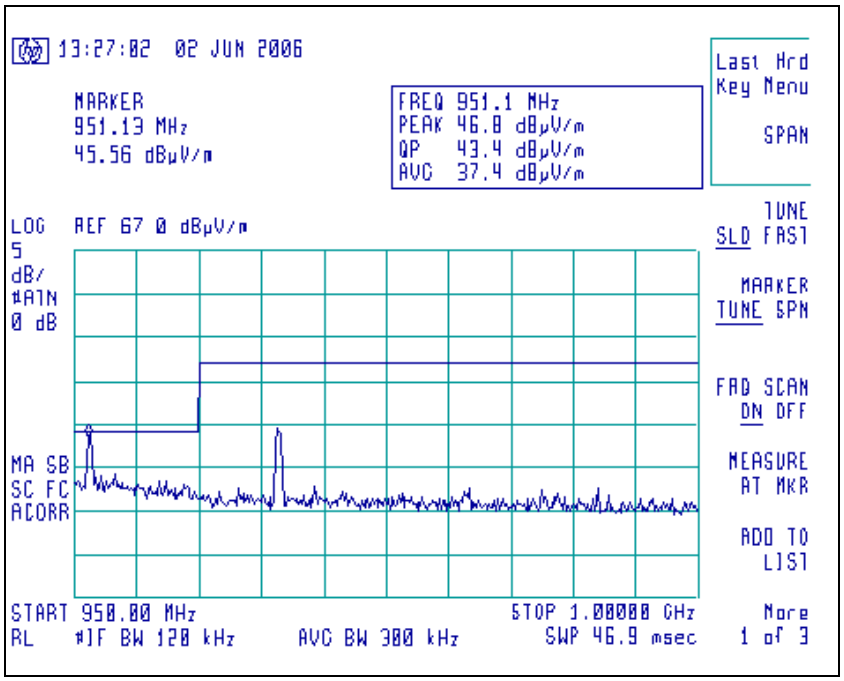
Lower Band-Edge



Upper Band-Edge 928 MHz – 950 MHz



Upper Band Edge 950MHz – 1000 MHz



For the upper band edge, the plot of the frequency range from 928 MHz up to 1000 MHz was divided into 2 separate ranges to show compliance with the restricted band present within it. The limit of 105 dBµV/m applies to frequencies ranging from 928MHz up to, but not including 960MHz while the limit for the rest of the frequencies in the plotted range is 54 dBµV/m.

10. Conducted RF Emissions onto AC Power Line

Test Setup

The Conducted Emissions test was performed at LS Research, LLC 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, Annex 8, Section 8.1). The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V 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 for 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:

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

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

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

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

Measurement of Electromagnetic Conducted Emission

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 (a)

Manufacturer:	Advanced Tracking Technologies, Inc.					
Date(s) of Test:	April 3rd – May 18th , 2006					
Test Engineer:	√	Aidi Zainal	√	Abtin Spantman		Ken Boston
Model #:	n/a					
Serial #:	05450375					
Voltage:	3.3 VDC					
Operation Mode:	Continuous transmit					
Test Location:	√	AC mains test bench				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

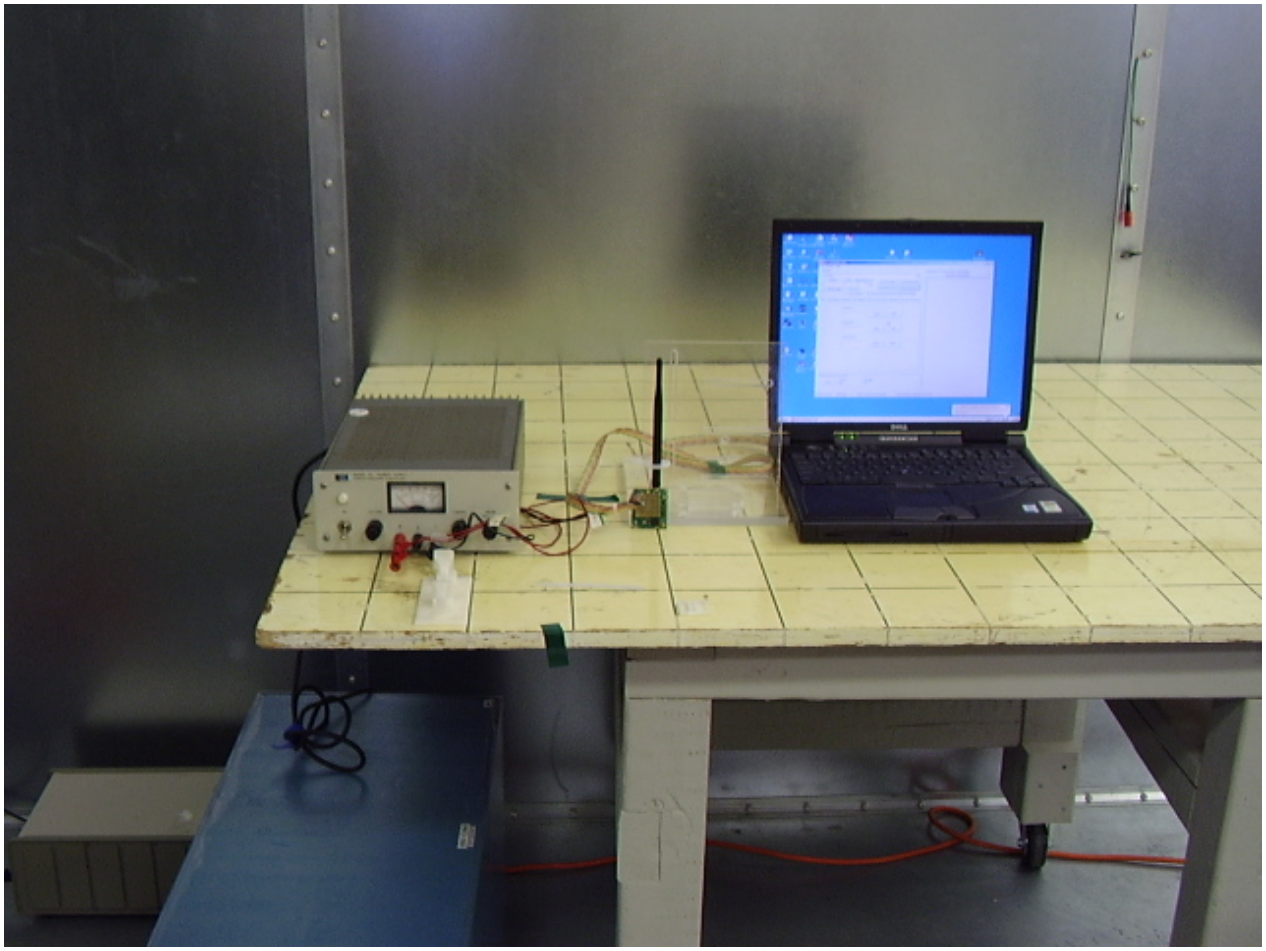
		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBµV/m)	Q-Peak Limit (dBµ V/m)	Quasi-Peak Margin (dB)	Average Reading (dBµV/m)	Average Limit (dBµ V/m)	Average Margin (dB)
0.195	L1	49.9	63.8	13.9	35.5	53.8	18.3
0.222	L1	46.1	62.7	16.6	22.9	52.7	29.8
0.292	L1	36.3	60.5	24.2	26.2	50.5	24.3
4.4	L1	15.9	56.0	40.1	9.4	46.0	36.6
15.2	L1	36.2	60.0	25.8	24.2	50.0	25.8
0.1973	L2	45.2	63.7	18.5	29.9	53.7	23.8
0.2926	L2	34.1	60.5	26.4	21.1	50.5	29.4
0.4843	L2	28.7	56.3	27.6	24.3	46.3	22.0
1.2	L2	30.5	56.0	25.5	29.5	46.0	10.5
15.2	L2	35.5	60.0	24.5	22.2	50.0	27.8

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) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

Photo(s) Taken During Conducted Emission Testing

Setup for the Conducted Emissions Test

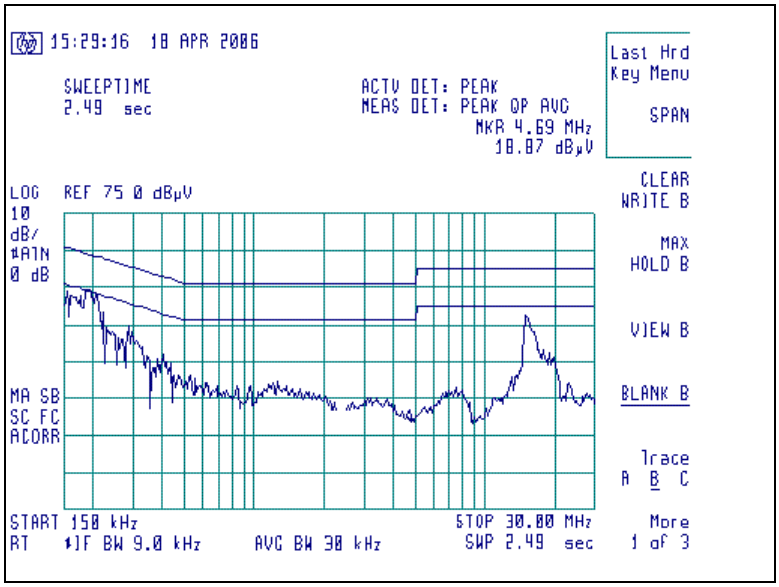


Screen Captures of Conducted AC Mains Emissions:

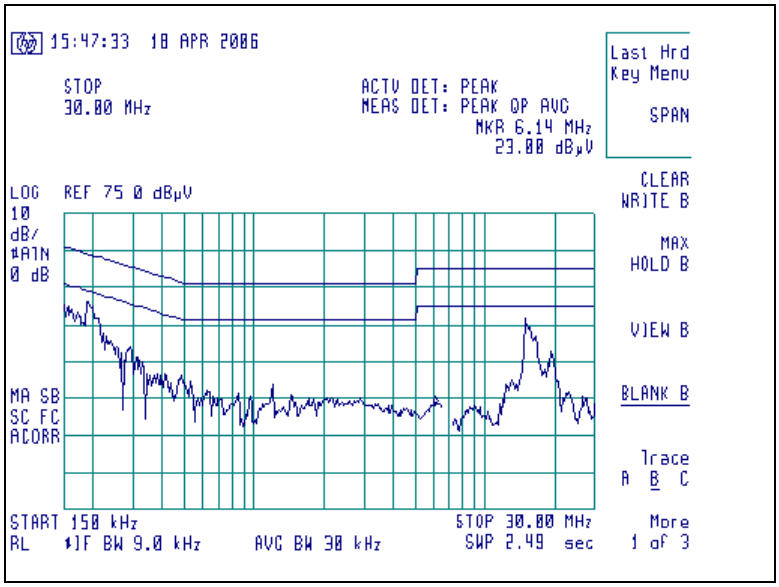
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

The signature scans shown here are from channel 27, chosen as being a good representative of channels.

Channel 27, 150 kHz - 30 MHz, Line 1



Channel 27, 150 kHz - 30 MHz, Line 2



11. Occupied Bandwidth

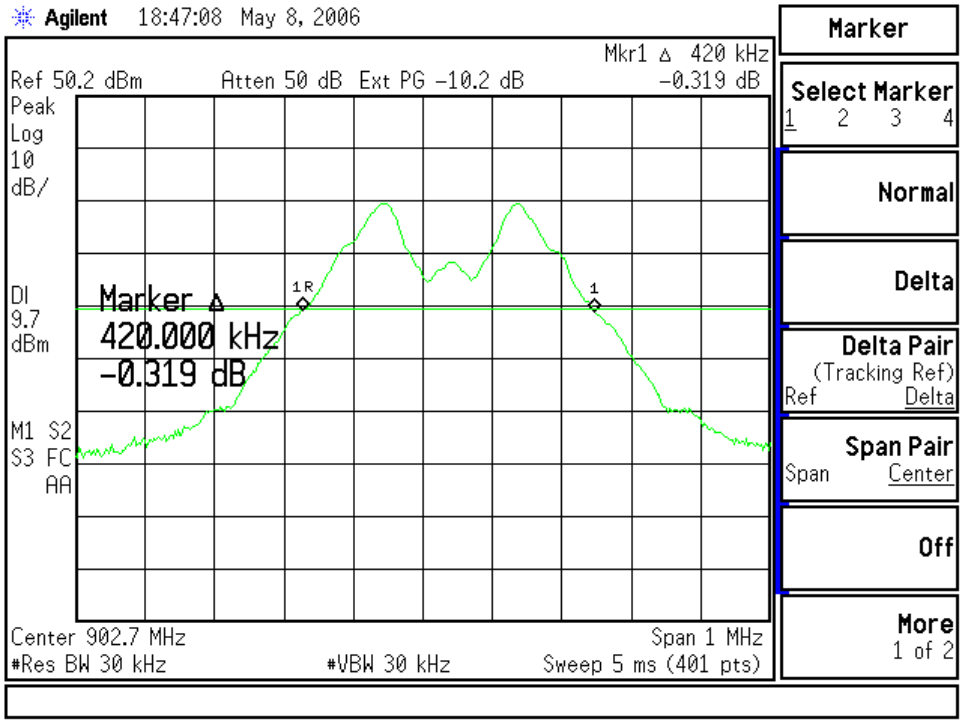
The 20 dB bandwidth requirement found in FCC Part 15.247(a)(1)(i) states a maximum allowed occupied bandwidth of 500 kHz. For this portion of the tests, a direct conducted measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to the HP E4407B spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were 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 10 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 420 kHz, which is below the maximum limit of 500 kHz.

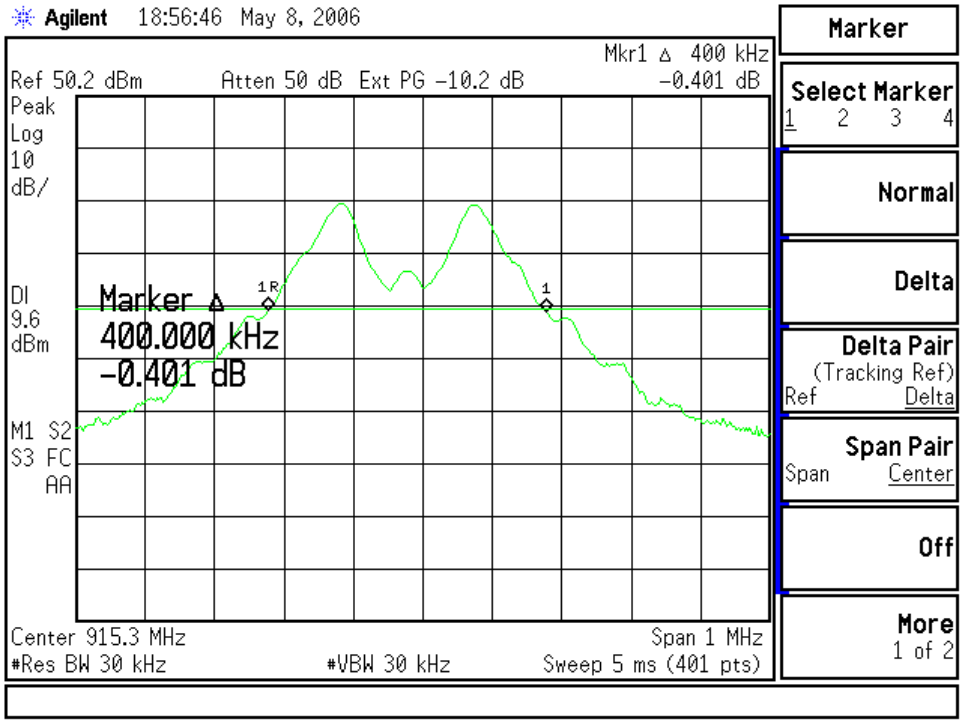
Channel	Center Frequency (MHz)	Measured 20 dB BW (kHz)	Maximum Limit (kHz)
00	902.7	420	500
27	915.3	400	500
52	927.2	400	500

Plots of Occupied Bandwidth

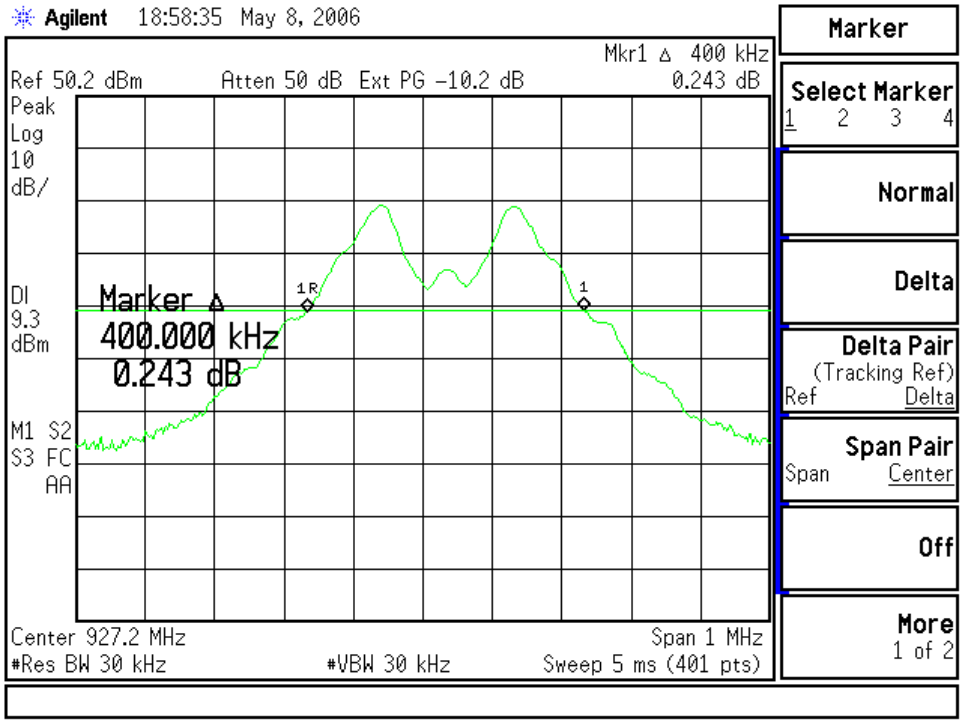
Channel 00 Occupied Bandwidth



Channel 27 Occupied Bandwidth



Channel 52 Occupied Bandwidth



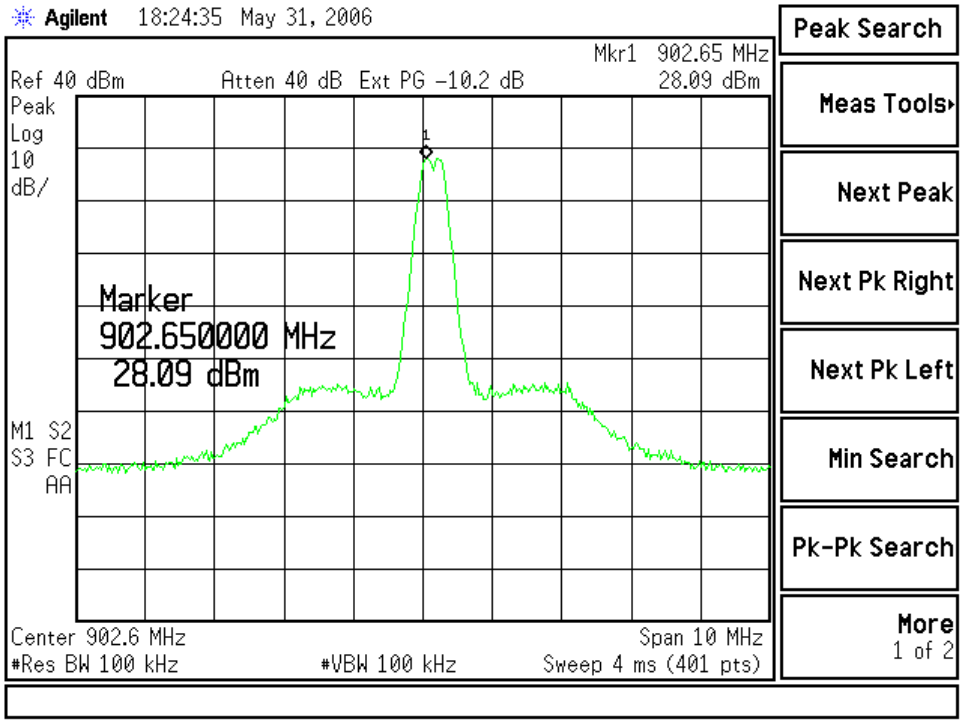
12. Power Output 15.247(b) (2)

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were 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, and a span of 1 MHz, with measurements from a peak detector presented in the chart below. RF Power Output was also monitored while varying the DC voltage as sourced by a DC bench type power supply.

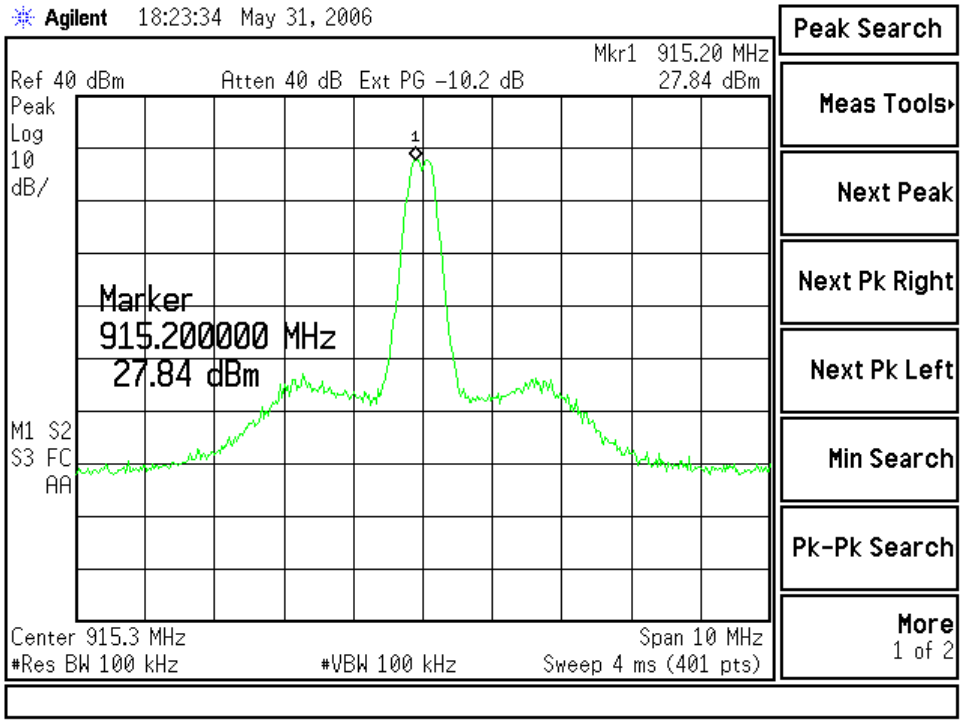
Voltage= 3.3 VDC

CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
00	902.7	30.0	28.6	1.4
27	915.3	30.0	28.3	1.7
52	927.2	30.0	28.0	2.0

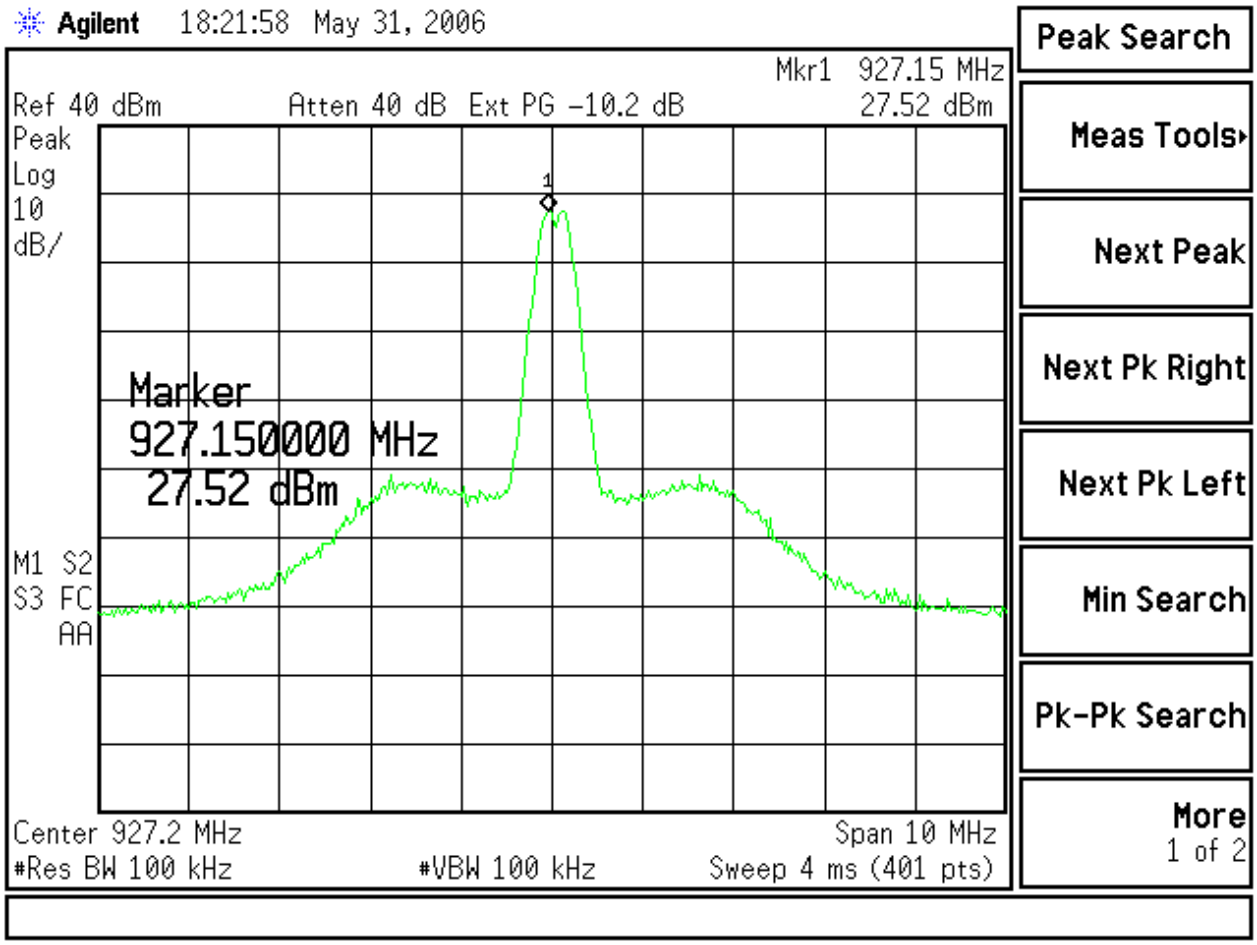
Channel 00 Conducted Power Output



Channel 27 Conducted Power Output



Channel 52Conducted Power Output



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 along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were 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 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 -50 dBc of the fundamental level for this product.

	Channel 00	Channel 27	Channel 52	Limit
Fundamental	28.1(dBm)	27.8(dBm)	27.5(dBm)	30.0
2nd Harmonic	-1.03(dBm)	-1.809(dBm)	-3.814(dBm)	8.1
3rd Harmonic	-38.1(dBm)	-41.2(dBm)	-41.7(dBm)	8.1
4th Harmonic	- 48.5 (dBm)	- 52.2 (dBm)	- 51.1 (dBm)	8.1
5th Harmonic	- 49.8 (dBm)	- 56.8 (dBm)	- 60.0 (dBm)	8.1
6th Harmonic	- 51.7 (dBm)	- 49.7 (dBm)	- 48.9 (dBm)	8.1
7th Harmonic	- 45.4 (dBm)	- 44.9 (dBm)	- 42.1 (dBm)	8.1
8th Harmonic	- 47.1 (dBm)	- 56.2 (dBm)	- 57.4 (dBm)	8.1
9th Harmonic	- 49.3 (dBm)	- 59.0 (dBm)	- 58.5 (dBm)	8.1
10th Harmonic	- 49.7 (dBm)	- 59.0 (dBm)	- 57.9 (dBm)	8.1

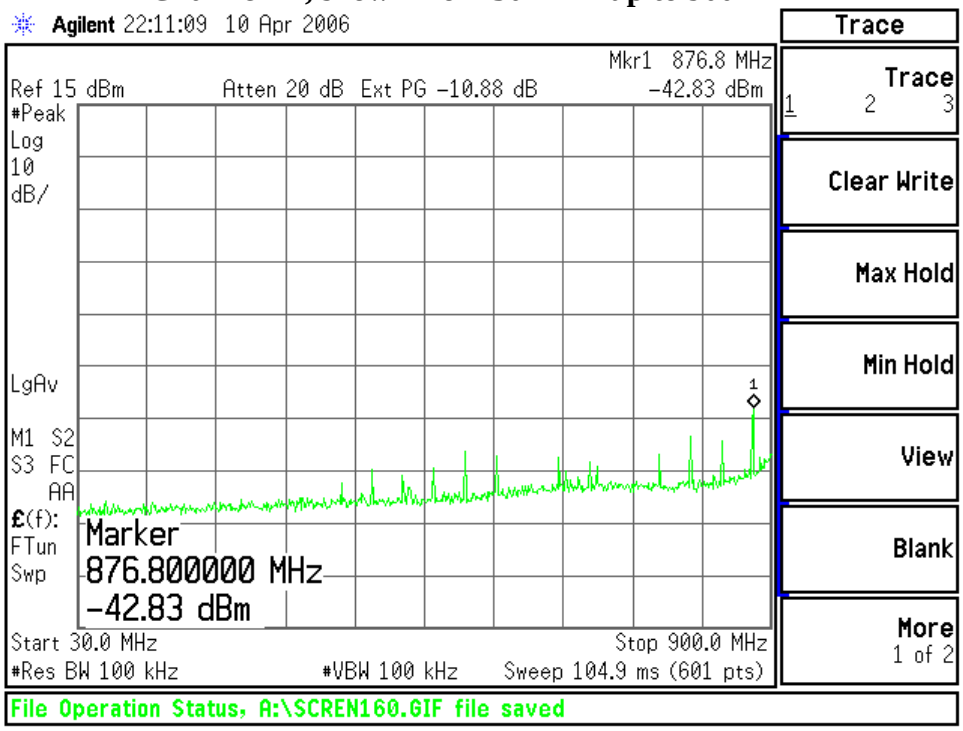
Notes:
(1) Measurement at system noise floor.

Spurious emissions other than harmonics.

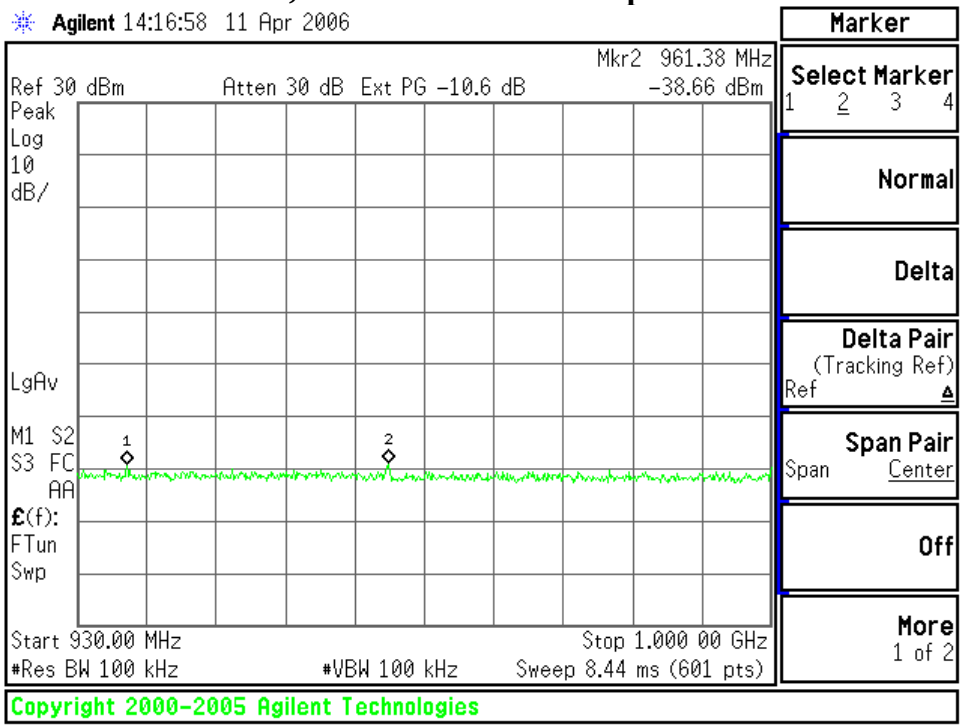
Frequency (MHz)	Channel	MEASURED POWER (dBm)	Limit (dBm)
906.5	27	- 46.7	7.8
924.2	27	- 43.5	7.8
993.4	27	- 45.8	7.8
954.2	27	- 42.6	7.8
1446.0	27	- 44.6	7.8
1476.0	27	- 45.8	7.8
1714.0	27	- 45.0	7.8
896.0	00	- 39.2	8.1
922.1	00	- 36.1	8.1
961.4	00	- 38.7	8.1
935.0	00	- 39.1	8.1
1330.0	00	- 46.1	8.1
1440.0	00	- 44.0	8.1
1720.0	00	- 45.2	8.1
912.0	52	- 38.0	7.5
942.1	52	- 43.6	7.5
966.1	52	- 44.1	7.5
1442.0	52	- 44.3	7.5
1541.0	52	- 47.2	7.5
1674.0	52	- 47.0	7.5
1722.0	52	- 45.3	7.5

Plots of Conducted Spurious Levels

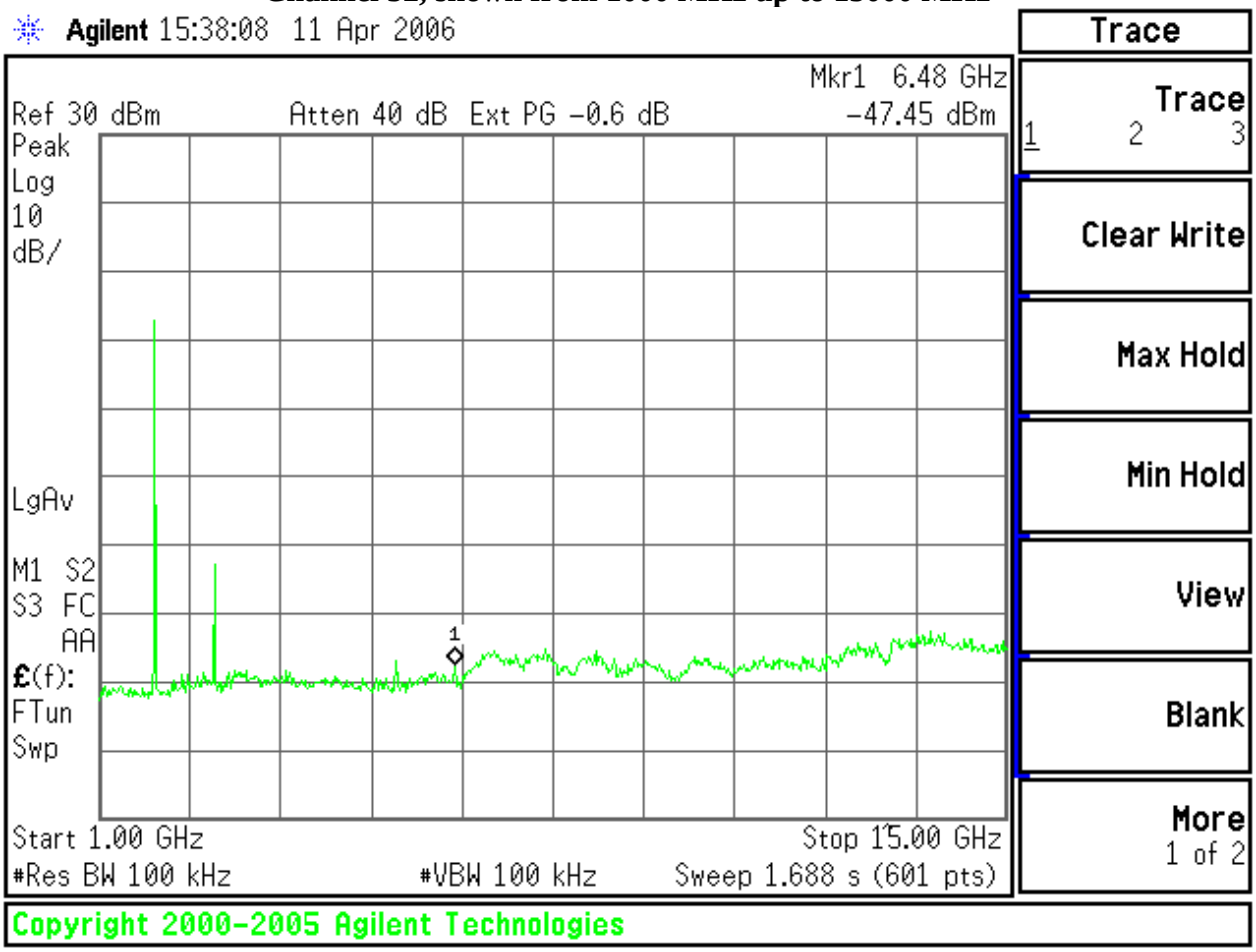
Channel 27, shown from 30 MHz up to 900 MHz



Channel 00, shown from 930 MHz up to 1000 MHz



Channel 52, shown from 1000 MHz up to 15000 MHz



14. Minimum Channel Separation

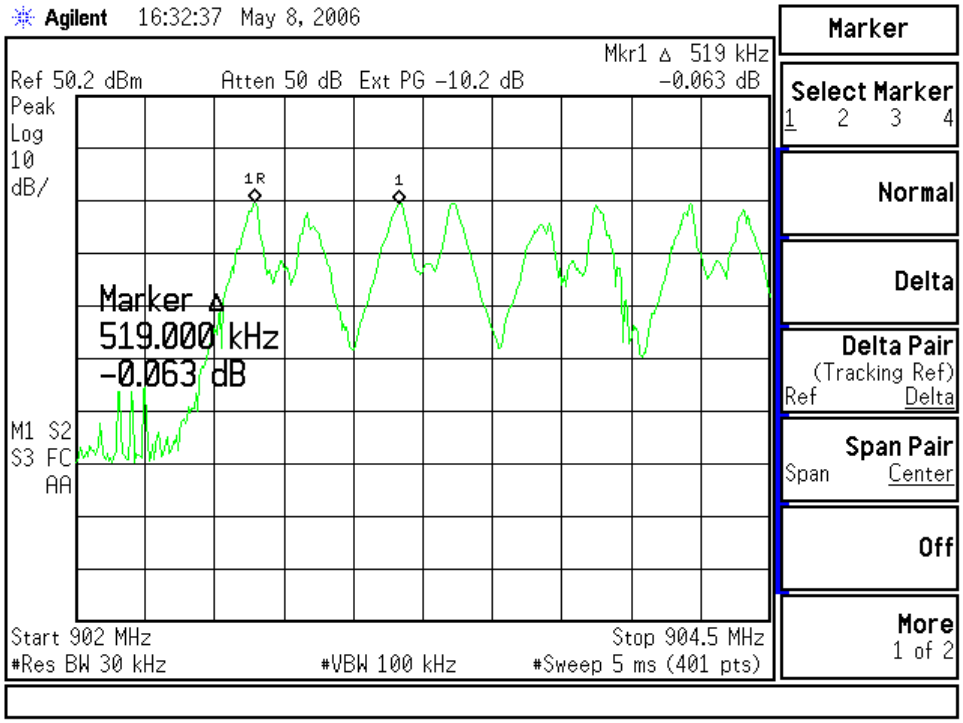
Part 15.247(a)(1) requires a minimum channel separation of 25 kHz or the equivalent of the 20 dB occupied bandwidth of the fundamental transmission, whichever is greater. An HP E4407B spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 425 kHz and 525 kHz. The maximum occupied bandwidth of the device, as reported in the previous section is 420 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. The following plots describe this spacing, and also establish the number of hop channels, total of 50.

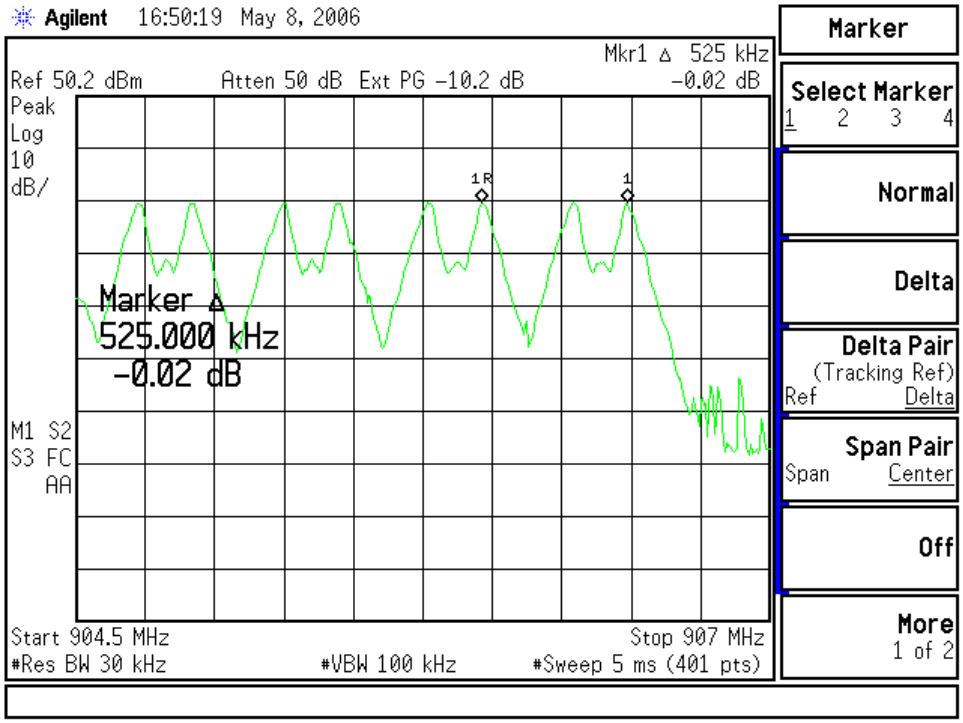
Frequency Span (MHz)	Number of Channels	Minimum Separation (kHz)
902.0 – 904.5	4	519.0
904.5 – 907.0	4	525.0
907.0 – 909.5	4	425.0
909.5 – 912.0	6	438.0
912.0 – 914.5	5	438.0
914.5 – 917.3	6	432.0
917.3 – 919.7	6	438.0
919.7 – 922.2	5	444.0
922.2 – 924.8	5	524.0
924.8 – 927.0	4	517.0
927.0 – 928.0	1	-
Total Channels:	50	

Plots of Channel Separations

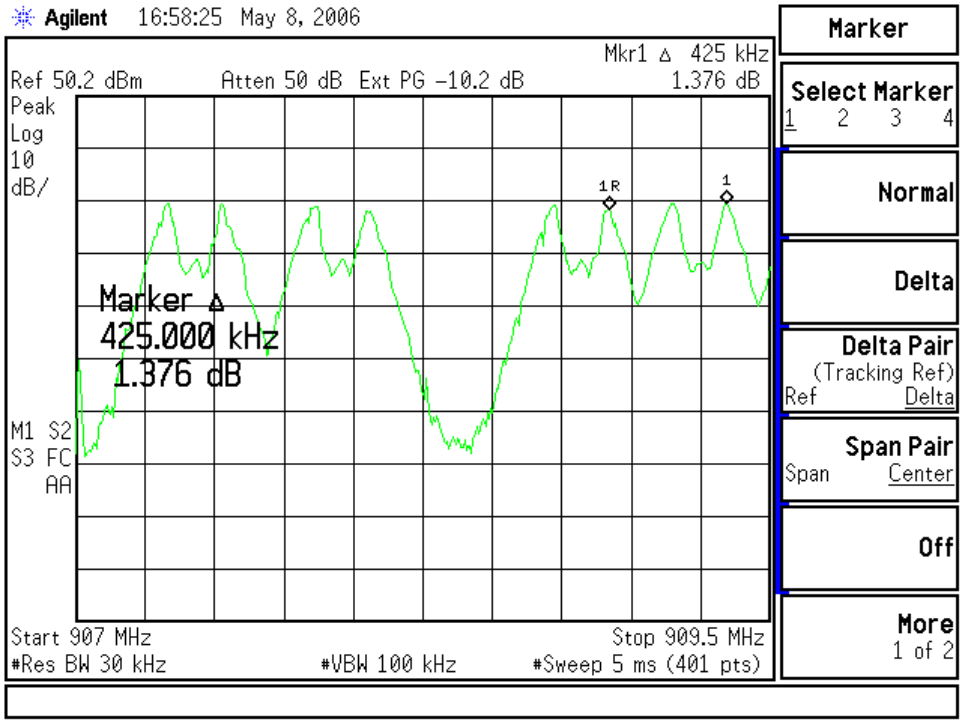
Channels 00 through 03



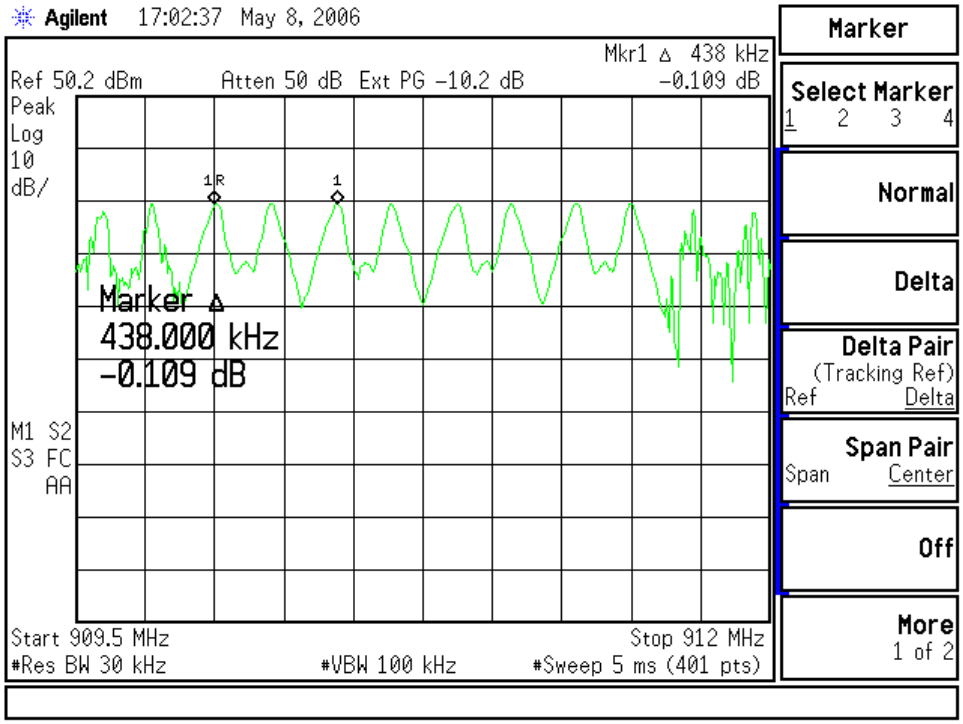
Channels 04 through 07



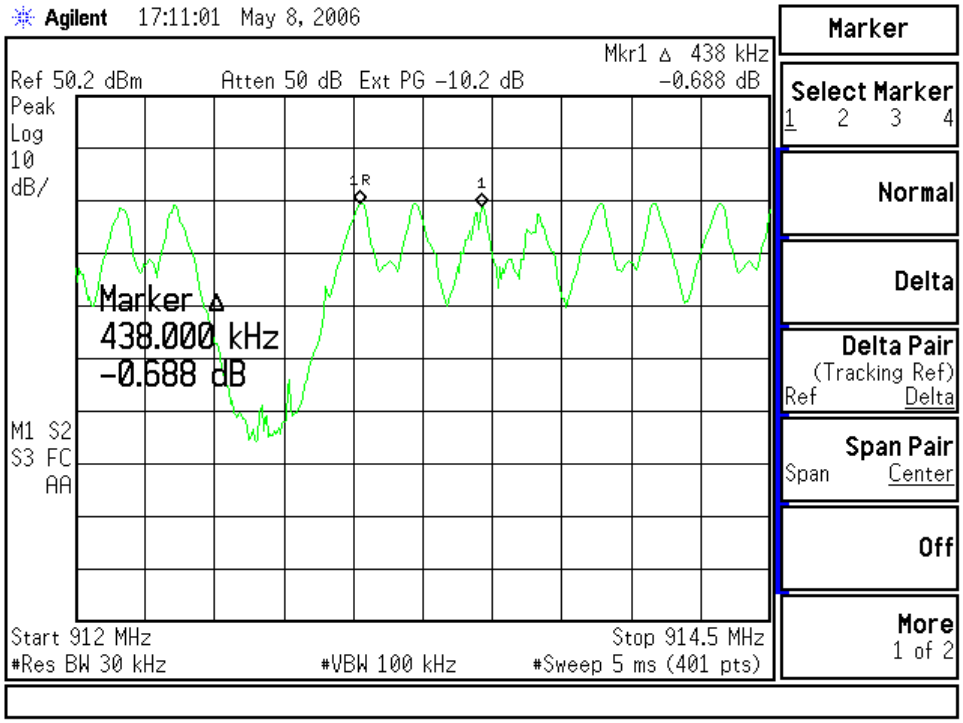
Channels 08 through 11



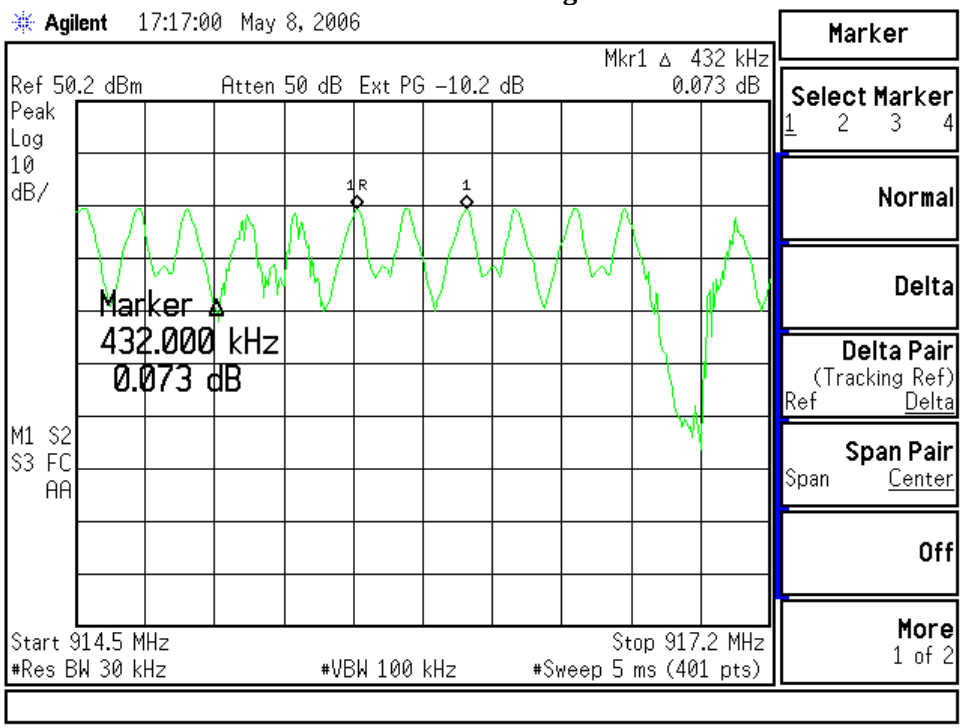
Channels 12 through 17



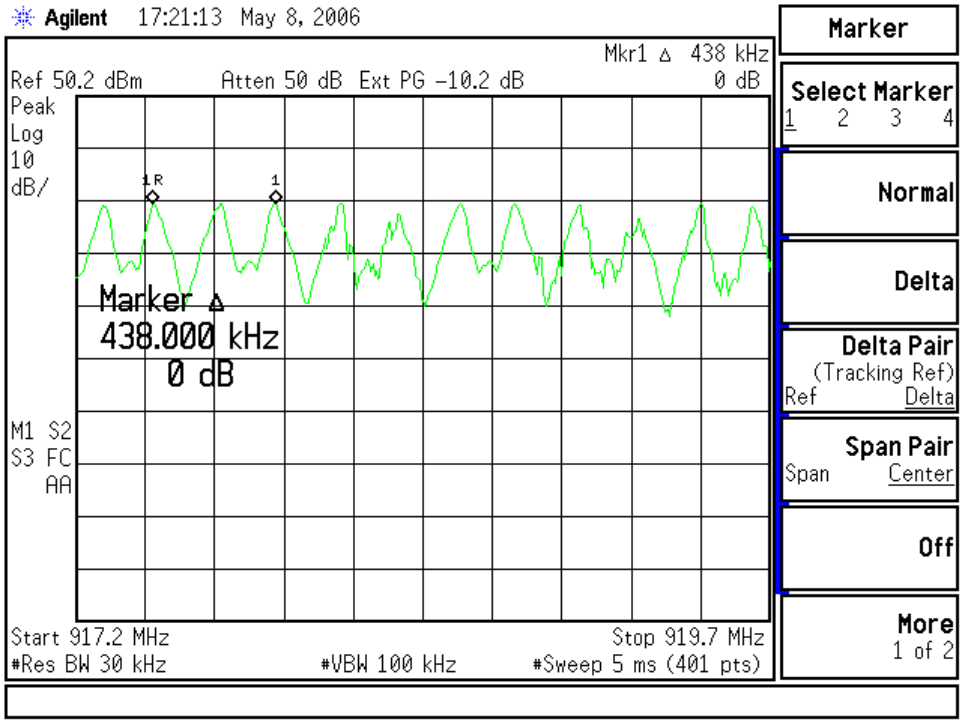
Channels 18 through 23



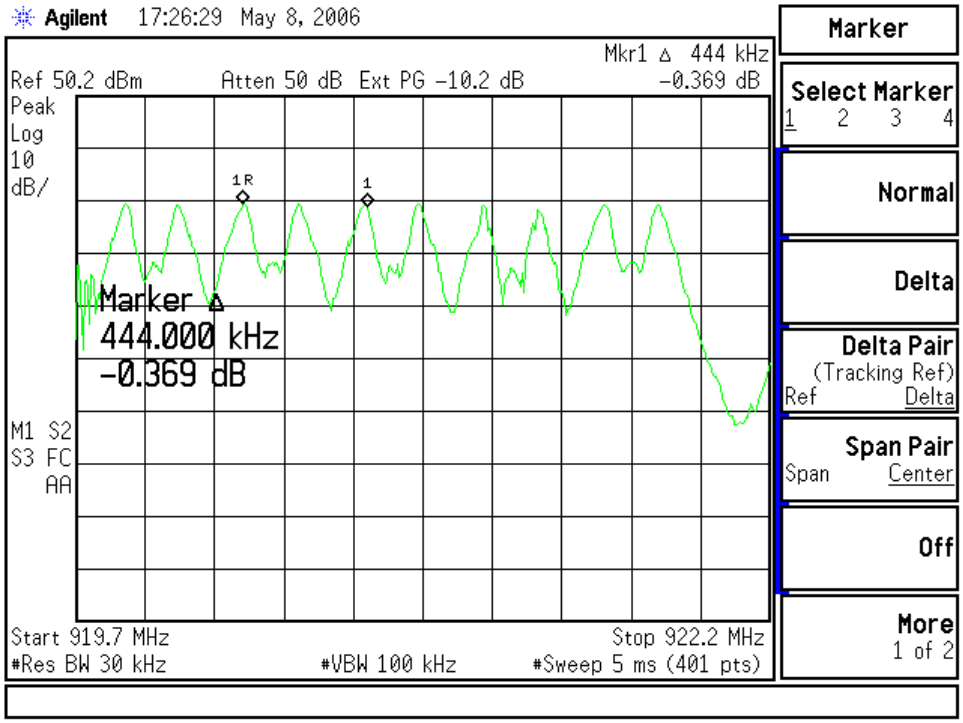
Channels 24 through 29



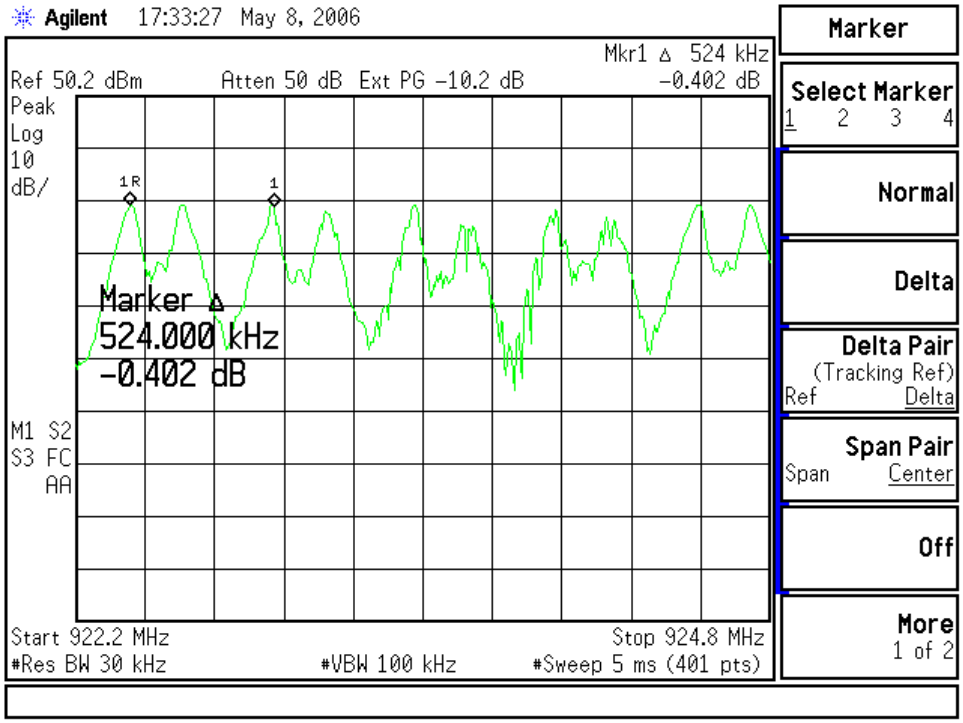
Channels 30 through 35



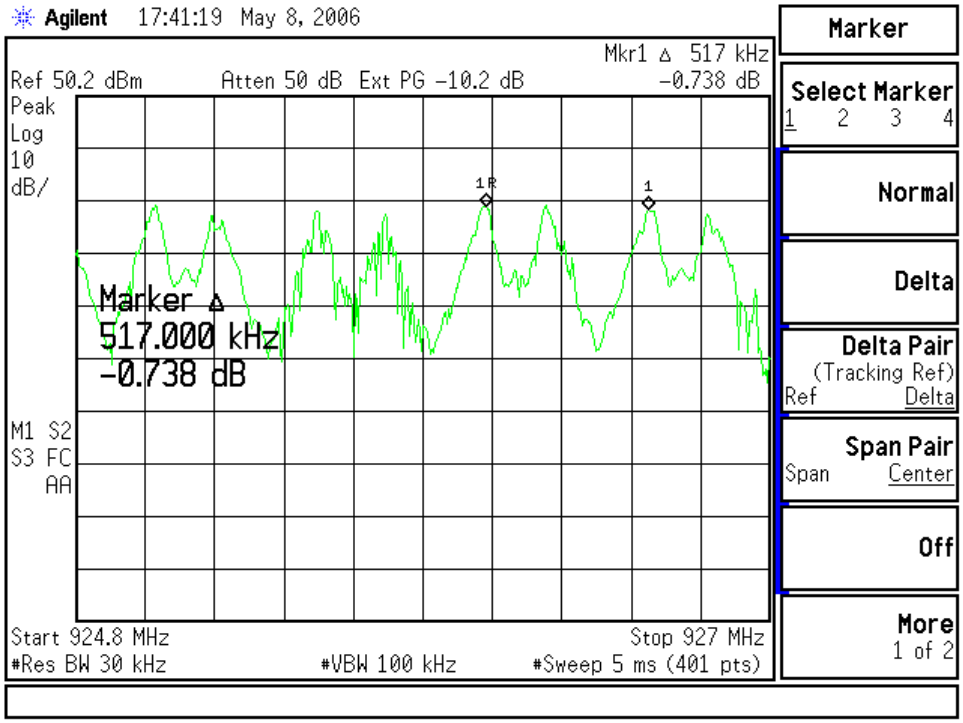
Channels 36 through 40



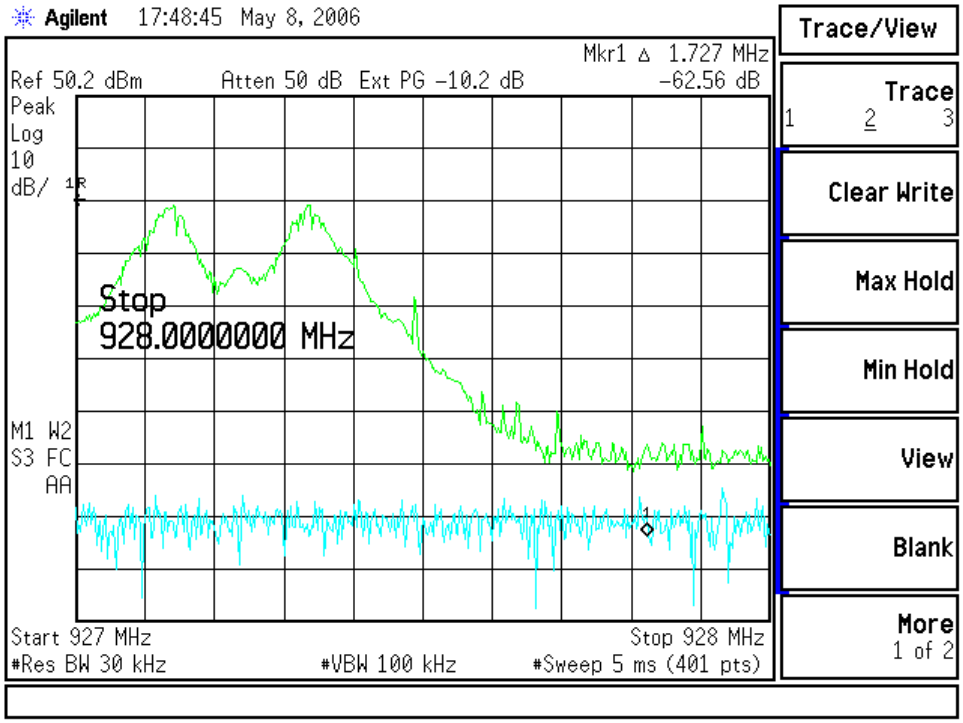
Channels 41 through 45



Channels 46 through 49



Channel 50


Agilent 17:48:45 May 8, 2006
Mkr1 Δ 1.727 MHz
Ref 50.2 dBm
Atten 50 dB Ext PG -10.2 dB
-62.56 dB
Peak
Log
10
dB/
Stop
928.0000000 MHz
M1 W2
S3 FC
AA
Start 927 MHz
#Res BW 30 kHz
#VBW 100 kHz
Stop 928 MHz
#Sweep 5 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2

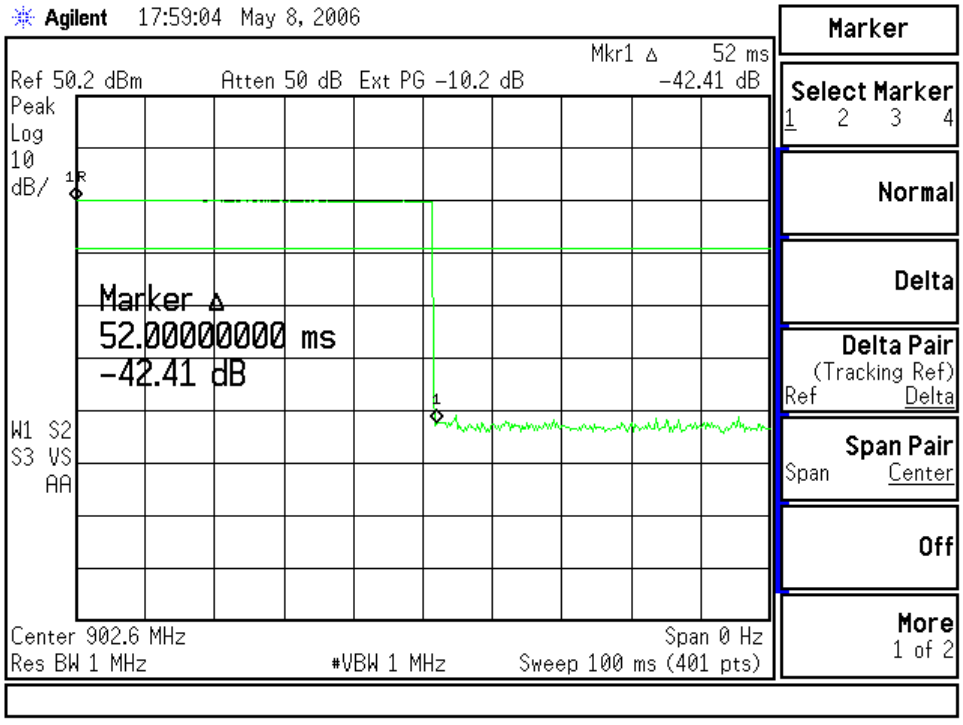
15. Channel Occupancy

Part 15.247(a)(1)(i) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 20 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 52.0 ms. With a total of 50 channels used, each occupying a 52.0 ms slot, it will take 2.6 seconds for the sequence to repeat. Therefore there will be 3.84 occurrences in a 10 second window for a maximum of 200ms occupancy. For this system, in a 10 second window, it occupies 156.0 ms.

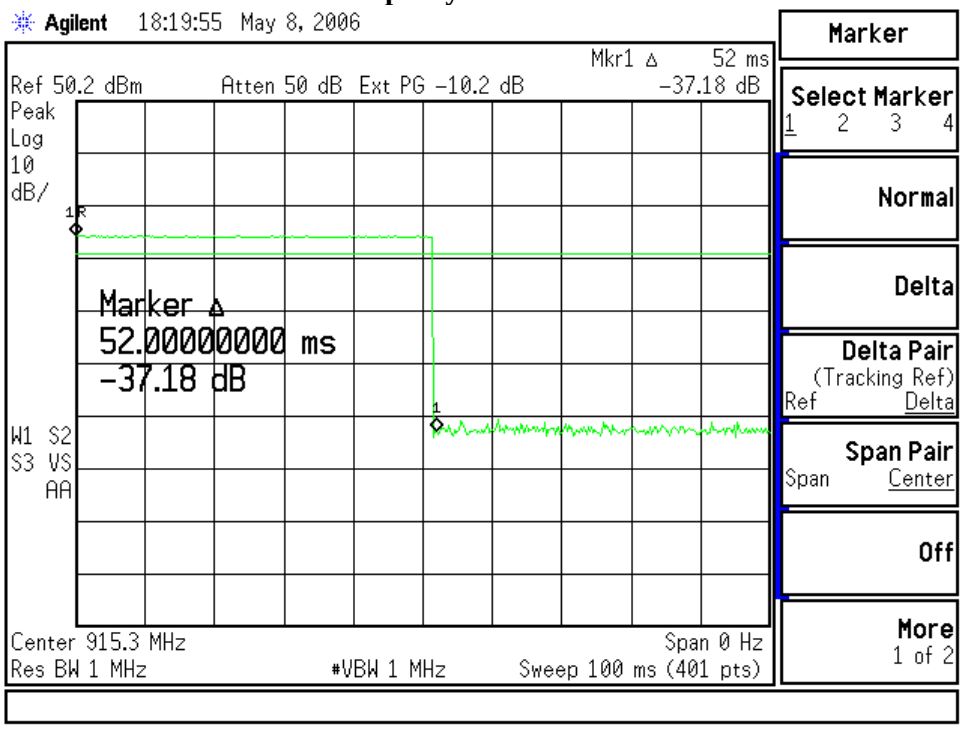
Channel	Frequency (MHz)	Occupancy Per transmission (ms)	Occupancy in a 10 second window (ms)
00	902.7	52.0	156
27	915.3	52.0	156
52	927.2	52.0	156

Plots of Channel Occupancy

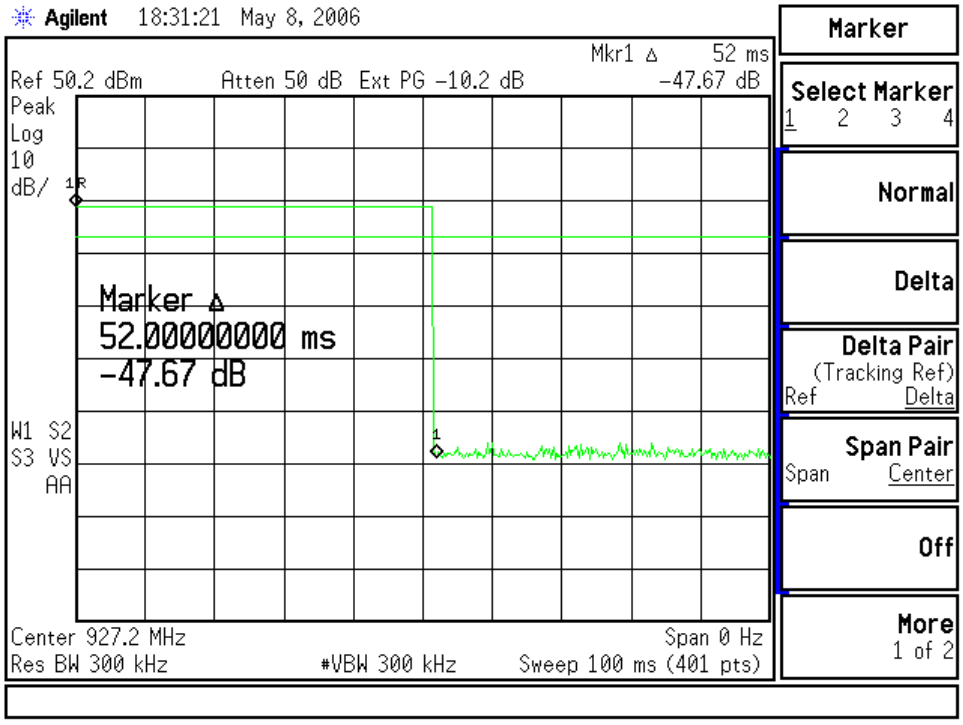
Occupancy in Channel 00



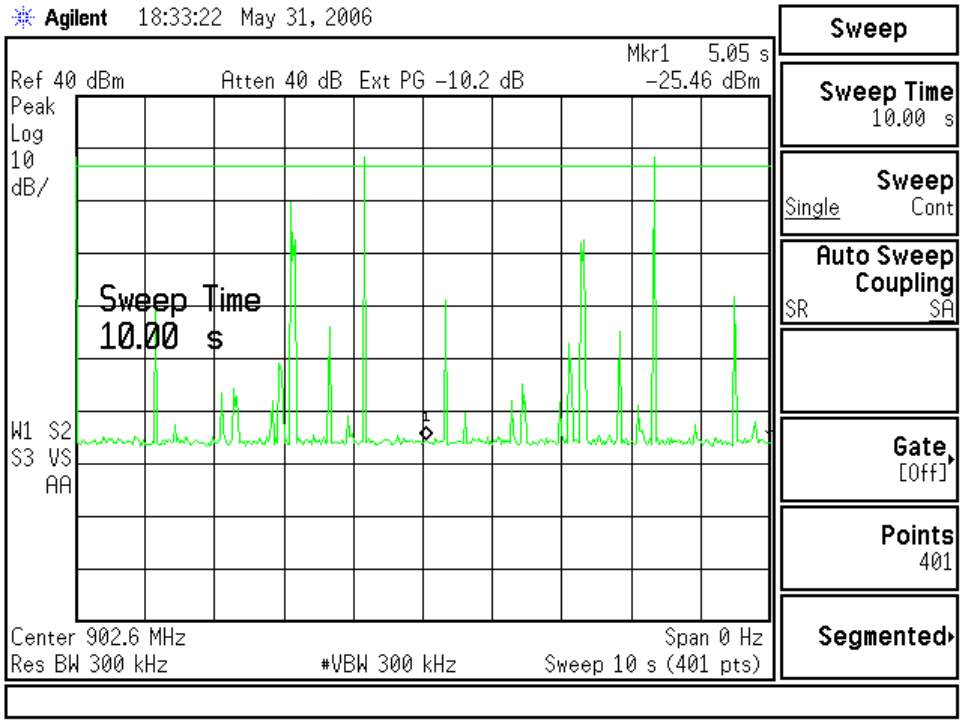
Occupancy in Channel 27



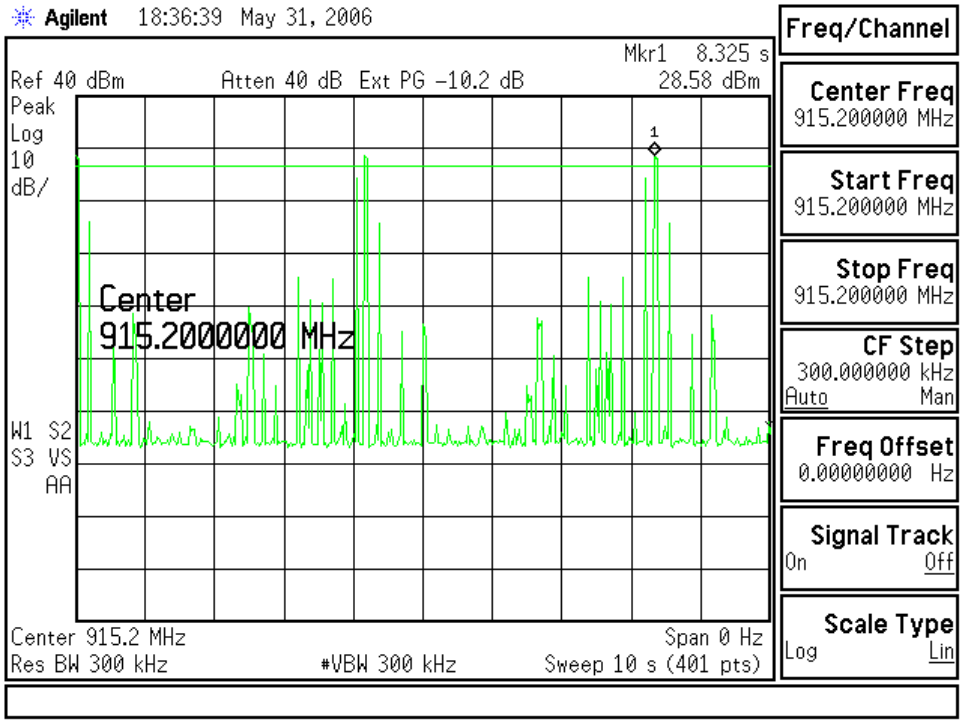
Occupancy in Channel 52



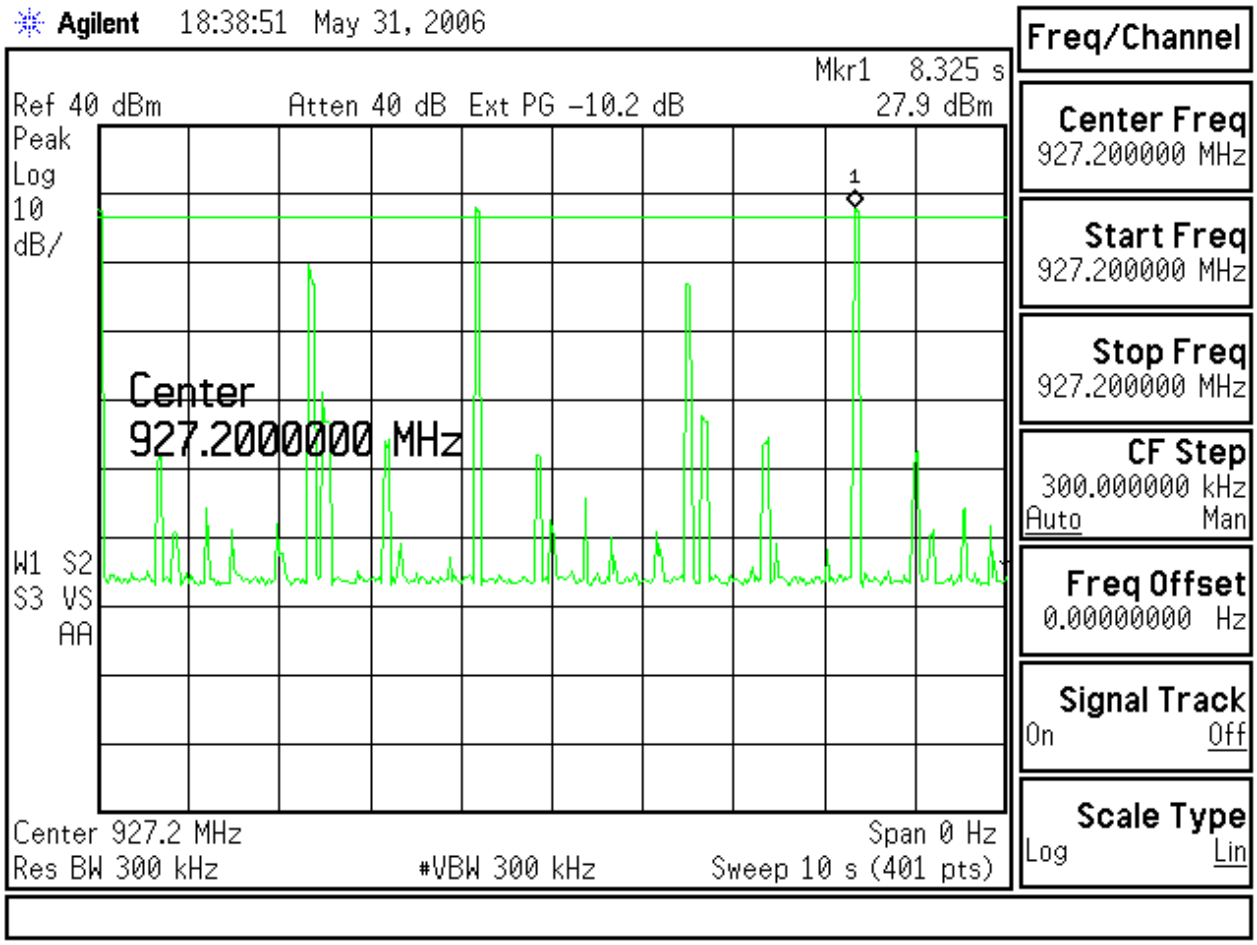
Occupancy in 10 second window, channel 00.



Occupancy in 10 second window, channel 27.



Occupancy in 10 second window, channel 52.



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 EUT is programmed to cease transmission when the supply voltage exceeds 3.5 VDC and measurements of power output reveals that at no time does the module exceed the 30 dBm limit at this supply voltage value. This feature was tested and verified to function as claimed. With the EUT operating at 2.8 VDC, the EUT did not show any signs of violating the 30 dBm limit as well..

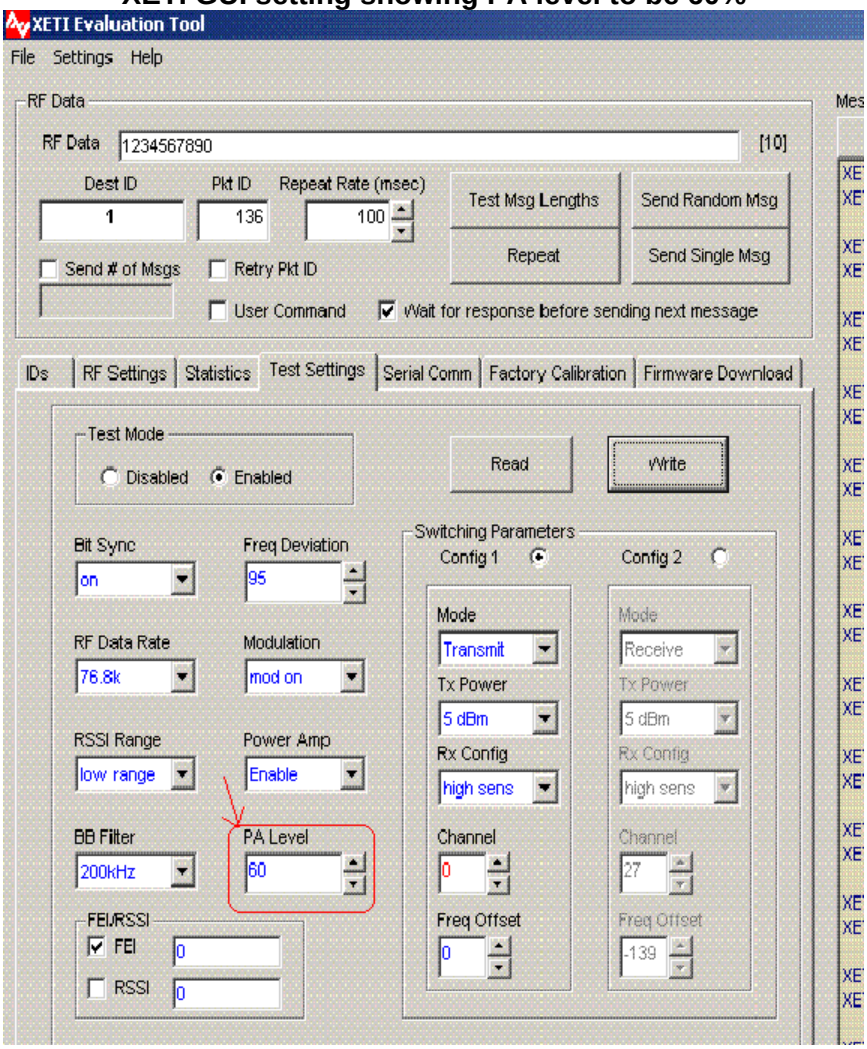
The output power was measured with a receiver resolution of 1 MHz, and video bandwidth of 1 MHz.

	DC Voltage Source		
	2.8 V	3.3 V	3.5 V
Channel	25.3 (dBm)	28.6 (dBm)	29.4 (dBm)
Channel	25.0 (dBm)	28.3 (dBm)	29.2 (dBm)
Channel	24.7 (dBm)	28.0 (dBm)	28.9 (dBm)

	DC Voltage Source		
	2.8 V	3.3 V	3.5 V
Channel 00	902.6 (MHz)	902.6 (MHz)	902.6 (MHz)
Channel 27	915.2 (MHz)	915.2 (MHz)	915.2 (MHz)
Channel 52	927.1 (MHz)	927.1 (MHz)	927.1 (MHz)

Note: The results of testing for output power above are based on a particular setting of factory calibration power level (For the unit tested, the setting was PA=60%). Any deviation from this level may result in different output power levels, as unit-to-unit variations, and hence all references should be with respect to the RF power output from the device, rather than the GUI setting. Please refer to screen capture of the XETI GUI on next page.

XETI GUI setting showing PA level to be 60%



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 -3.3/+0.8 dB, during the voltage variation tests.

The information on this page is provided by the manufacturer.

17. Equal Channel Usage

50 channels are chosen from a pool of 53 available frequencies. These 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.

18. Pseudorandom Hopping Pattern

The hopping table is built using an 8 bit seed into an $X^{15}+1$ pseudorandom number generator giving the possibility of 256 unique pseudorandom hopping tables. Output from the generator is used to pick frequencies from a pool of 53 available channels.

19. Receiver Synchronization

Each receiver requires the same seed for the pseudorandom sequence generator as the transmitter it is operating with. The same seed will produce the same hop sequence in each device. Once the receiver scans and finds the transmitter on any given channel it will automatically be synchronized to go to the next correct channel by virtue of using the same hopping table.

20. Receiver Input Bandwidth

The radio receiver is a direct conversion type with a baseband filter whose cut-off frequency is matched to the transmission spectrum. The bandwidth is 600 kHz for use at the 76.8 kbps rate. Two level frequency shift keying is used for modulation. The simple Carson bandwidth for this type of signal is given as the bit rate plus 2 times the deviation. This system uses 114 kHz deviation for the 76.8 kbps rate, giving a bandwidth of 304.8 kHz. The excess filter bandwidth allows for frequency tolerance errors between the transmitter and receiver.

21. MPE Calculations

Base Station Transceiver
MPE Calcluation

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:	28.09	(dBm)
Maximum peak output power at antenna input terminal:	644.169	(mW)
Antenna gain(typical):	2	(dBi)
Maximum antenna gain:	1.585	(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:	0.203109	(mW/cm^2)
Maximum allowable antenna gain:	6.8	(dBi)
Margin of Compliance at 20 cm =	4.8	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 for antenna used on module during testing.