LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012 ● USA
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ENGINEERING TEST REPORT # 306465 TX

Compliance Testing of:
UVAC03

Test Date(s):
October 4th to 11th 2006

Prepared For:
I.D. Systems, Inc.
One University Plaza Drive
Suite 600
Hackensack, NJ 07601

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 902 MHz – 928 MHz

This Test Report is issued under the Authority of:
Brian Petted, VP of Engineering

Signature: Date: February 27, 2007

Test Report Prepared by:	**Tested by:**
K. Aidi Zainal, Sr. EMC Engineer	Abtin Spantman, RF/EMC Engineer
Signature: Date: February 27, 2007	Signature: Date: February 27, 2007

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LSC Revision Control

Date	Revision #	Revised By
9-06-06	2.0	AS/TAW

EXHIBIT 1. INTRODUCTION

1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.247
Title:	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Digital Modulation Transmitters operating in the Frequency Band of 902 MHz to 928 MHz
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – 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.
Environmental Classification:	• Commercial, Industrial or Business • Residential

1.2 NORMATIVE REFERENCES

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2005	Code of Federal Regulations - Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
FCC Procedures	2005, 03-23	Measurement of Digital Transmission Systems operating under Section 15.247.

1.3 LS Research, LLC TEST FACILITY

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. A copy of the accreditation may be accessed on our web site: www.lsr.com. Accreditation status can be verified at A2LA's web site: www.a2la2.net.

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

List of Facilities Located at LS Research, LLC:

- Compact Chamber
- Semi-Anechoic Chamber
- Open Area Test Site (OATS)

1.5 TEST EQUIPMENT UTILIZED

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated in accordance with A2LA standards.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**I.D. Systems, Inc.**
Address:	**One University Plaza Drive** **Sixth Floor** **Hackensack NJ 07601**
Contact Person:	**Leonard Pimentel**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	UVAC03 (LISA)
Model Number:	UVAC03
Serial Number:	05-VP392808-FLX

2.3 ASSOCIATED ANTENNA DESCRIPTION

The antenna used on the EUT was a muRata LDA 8220D non-ground quarter wavelength linear chip antenna.

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	902 MHz to 928 MHz
RF Power in Watts	0.0468 Watts
Field Strength (and at what distance)	104.5 dBµV/m at 3m (915.0 MHz)
Occupied Bandwidth (99% BW)	805 kHz (-20 dBc) and 540 kHz (6 DBc)
Type of Modulation	FSK
Emission Designator	F1D805K
Transmitter Spurious (worst case)	44.3 dBµV/m (at 1854 MHz)
Frequency Tolerance %, Hz, ppm	Better than 100 PPM
Microprocessor Model # (if applicable)	N/A
EUT will be operated under FCC Rule Part(s)	47 CFR 15.247
Modular Filing	☐ Yes ☒ No

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	√	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

- Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
- Duty Cycle used in evaluation: 100 %
- Standard used for evaluation: 47 CFR 15.247, RSS 210
- Measurement Distance: 3 m
- RF Value: 0.168 ☒ V/m ☐ A/m ☐ W/m^2
  ☒ Measured ☐ Computed ☐ Calculated

2.5 PRODUCT DESCRIPTION

The product name is UVAC03 (LISA). It is a DTS system with a half Duplex 902-928 MHz radio used for wireless remote access of ground transport Equipment like trucks, forklifts, etc. Type of modulation employed is a 2 level FSK. The EUT requires +6.4 VDC. The unit by default is in receive mode, but can be switched to transmission mode via user interface. The operator can return the radio back to receive mode by either the user interface or by power cycling. However, access to frequency channels, communication screens and power settings are NOT available to the operator.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	72º
Humidity:	40%
Pressure:	736 mmHg

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Paragraph	Test Requirements	Compliance (yes/no)
15.207	Power Line Conducted Emissions Measurements	Yes
15.247(a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
15.247(b) & 1.1310	Maximum Output Power	Yes
15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
15.247(c), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers. The Receiver Test Report is available upon request.		

3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

☒ **None** ☐ **Yes (explain below)**

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

☒ **None** ☐ **Yes (explain below)**

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210 (2005), Section Annex 8 (section 8.2) for a Digital Spread Spectrum (DTS) Transmitter.

If some emissions are seen to be within 3 dB 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.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 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 bench DC power supply which was able to supply +6.4 VDC to the EUT. The unit has the capability to operate on 3 channels, controllable via keypads on the face of the EUT.

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 (902.6 MHz), middle (915.2 MHz) and high (927.2 MHz) to comply with FCC Part 15.35. The channels and operating modes were changed using controllable via keypads on the face of the EUT

5.2 Test Setup Photo(s) – Radiated Emissions Test

Vertical Orientation

Horizontal Orientation

Side Orientation

EUT on Test Pedestal

5.3 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 axes during the investigations to find the highest emission levels.

5.4 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 18 GHz, an HP E4407B Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the HP E4407B Spectrum Analyzer with a standard gain horn, and preamp were used.

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
EMI Receiver Pre-Select.	HP	85460A	3448A00296
Spectrum Analyzer	Agilent	E4446A	US45300564
Log Periodic Antenna	EMCO	93146	9701-4855
Horn Antenna	EMCO	3115	6907
Bicon Antenna	EMCO	93110B	9702-2918
Pre-Amp	Adv. Microwave	WLA612	1145A04094
Horn Antenna – Std. Gain	EMCO	3160-09	9809-1120

5.5 Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a DTS transmitter [Canada RSS-210 (2005), Annex 8 (section 8.2). The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.6 CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3), is 1 Watt. 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 general radiated emission limits above 30 MHz. 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	-
960-24,000	500	54.0	63.5

Sample conversion from field strength μV/m to dBμV/m:
$dB\mu V/m = 20 \log_{10} (100)$
= 40 dBμV/m (from 30-88 MHz)

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

960 MHz to 10,000 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 9.5 = 63.5 dB/μV/m at 1 meter

For measurements made at 0.3 meter, a 20 dB correction has been invoked.

960 MHz to 10,000 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 20 = 74 dB/μV/m at 0.3 meters

5.7 RADIATED EMISSIONS DATA CHART

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

Manufacturer:	ID Systems						
Date(s) of Test:	October 4th to 11th 2006						
Test Engineer(s):	Abtin Spantman						
Voltage:	+6.4 VDC						
Operation Mode:	Continuous transmit						
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %						
EUT Power:		Single Phase ___VAC		3 Phase ___VAC			
		Battery	√	Other: Bench DC 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	

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

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.205 Limit (dBμV/m)	Margin (dB)
80.0	V/S	1.00	0	21.1	40.0	18.9
120.0	V/S	1.00	102	29.6	43.0	13.4
156.0	V/S	1.00	0	27.1	43.0	15.9

RADIATED EMISSIONS DATA CHART *(continued)*

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

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
902.6	H/H	1.00	105	104.4	125.2	20.8
1805.2	V/S	1.00	336	37.9	84.4	46.5
2707.8	V/S	1.05	79	37.5	54.0	16.5
3610.4	V/S	1.00	0	34.1	54.0	19.9
4513.0	Note 3					
5415.6	H/H	1.00	0	33.5	54.0	20.5
6318.2	H/H	1.00	270	36.0	84.4	48.4
7220.8	Note 3					
8123.4	H/H	1.00	250	40.3	54.0	13.7
9026.0	Note 3					

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

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
915.2	H/H	1.00	95	104.5	125.2	20.7
1830.4	V/S	1.00	211	41.5	84.5	43
2745.6	V/S	1.50	165	34.9	54.0	19.1
3660.8	V/S	1.09	105	38.5	54.0	15.5
4576.0	Note 3					
5491.2	H/H	1.00	15	37.8	84.5	46.7
6406.4	H/H	1.05	275	35.4	84.5	49.1
7321.6	Note 3					
8236.8	H/H	1.05	45	39.3	54.0	14.7
9152.0	Note 3					

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

Frequency (MHz)	Ant./EUT Polarity	Height (meters)	Azimuth (0° - 360°)	Measured EFI (dBμV/m)	15.247 Limit (dBμV/m)	Margin (dB)
927.2	H/H	1.52	98	102.5	125.2	22.7
1854.4	V/S	1.06	264	44.3	82.5	38.2
2781.6	V/S	1.00	0	33.7	54.0	20.3
3708.8	V/S	1.25	56	39.1	54.0	14.9
4636.0	Note 3					
5563.2	H/H	1.05	180	45.3	82.5	37.2
6490.4	H/H	1.15	160	37.9	82.5	44.6
7417.6	Note 3					
8344.8	H/H	1.10	180	39.7	54.0	14.3
9272.0	Note 3					

Notes:

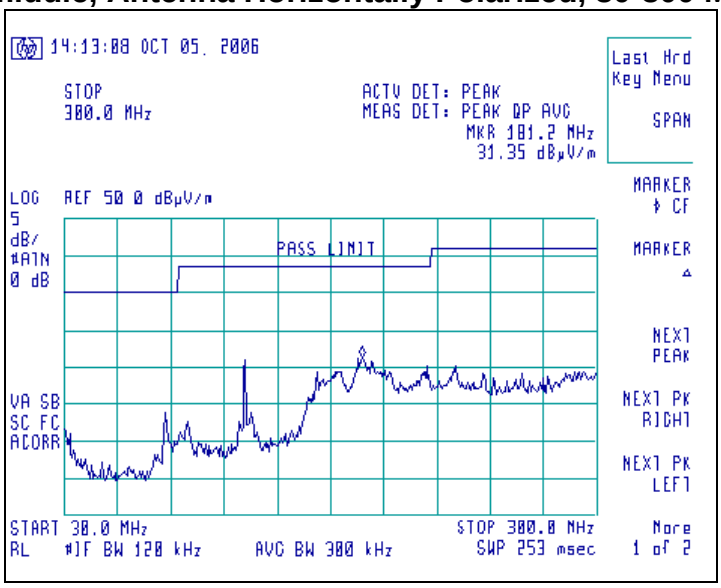
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Only the results from the Average detector are published in the table above. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 5 GHz were made at 1 meters of separation from the EUT.
3) Measurement at receiver system noise floor.
4) For measurements of the fundamental power, because of spectral bandwidth, the receiver was set to RBW=VBW=1 MHz.

5.8 Screen Captures - Radiated Emissions Testing

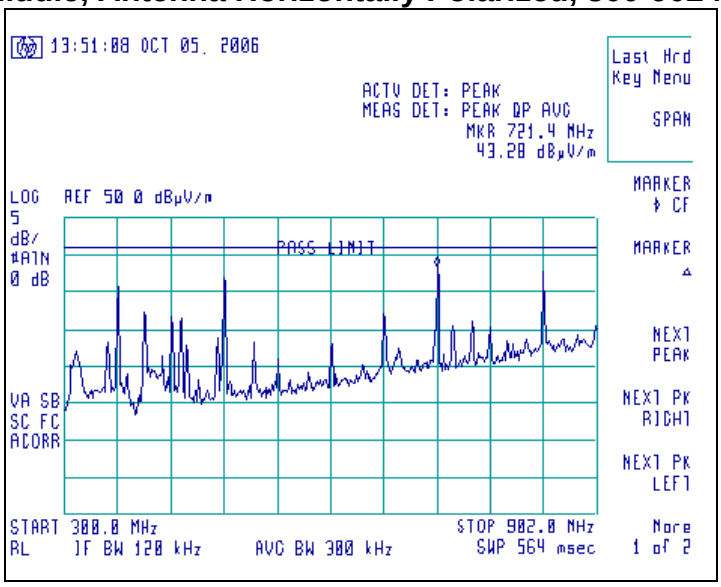
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels low, middle, or high, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel middle, Antenna Horizontally Polarized, 30-300 MHz, at 3m

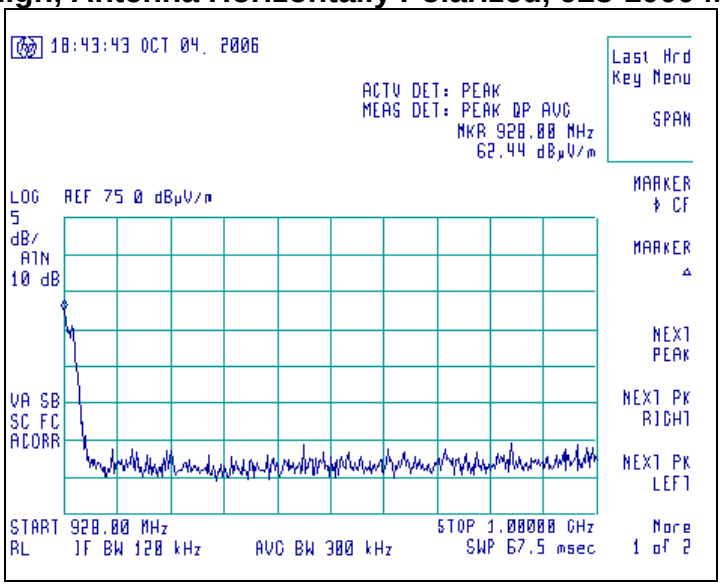


Channel middle, Antenna Horizontally Polarized, 300-902 MHz, at 3m

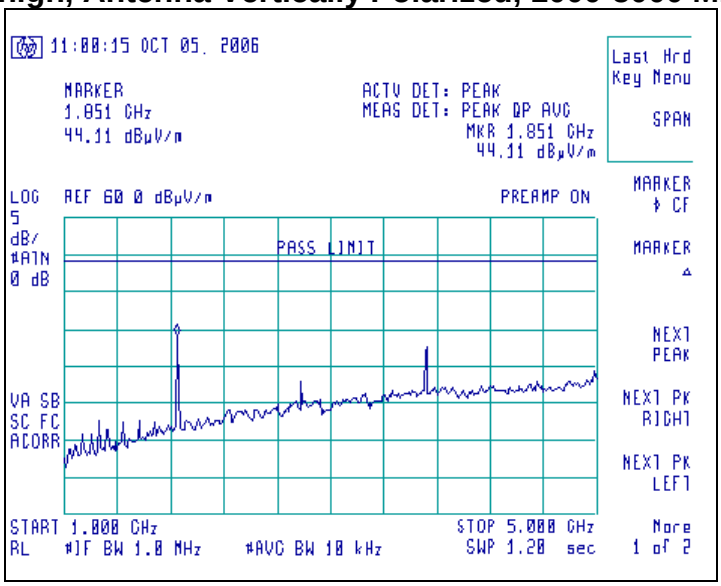


Screen Captures - Radiated Emissions Testing *(continued)*

Channel high, Antenna Horizontally Polarized, 928-1000 MHz, at 3m



Channel high, Antenna Vertically Polarized, 1000-5000 MHz, at 3m



Screen Captures - Radiated Emissions Testing *(continued)*

Channel high, Antenna Vertically Polarized, 5000-10000 MHz, at 1m

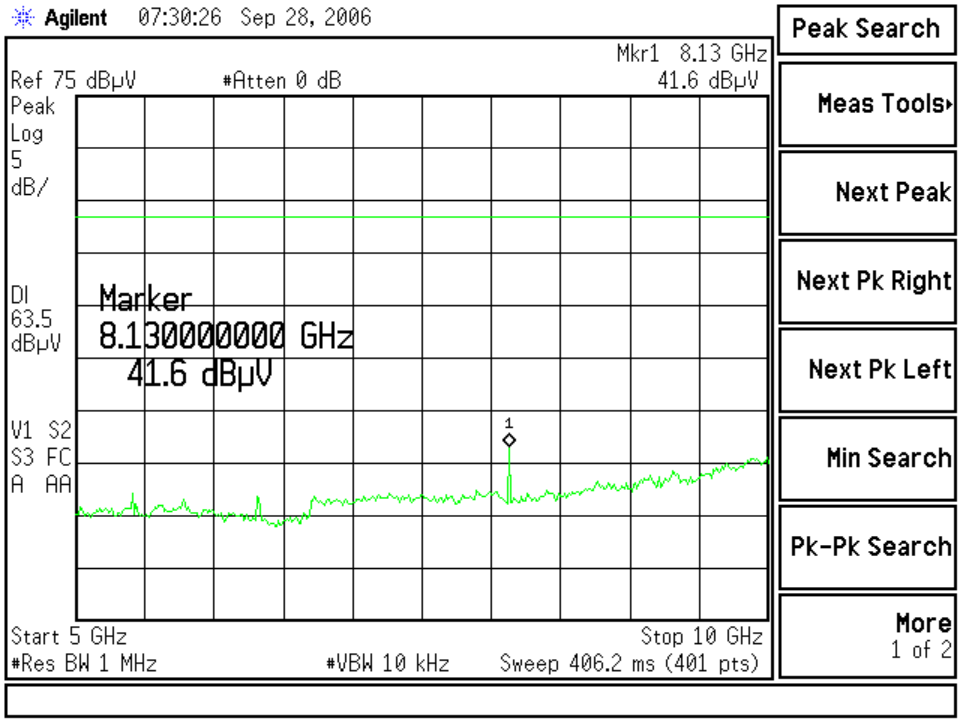
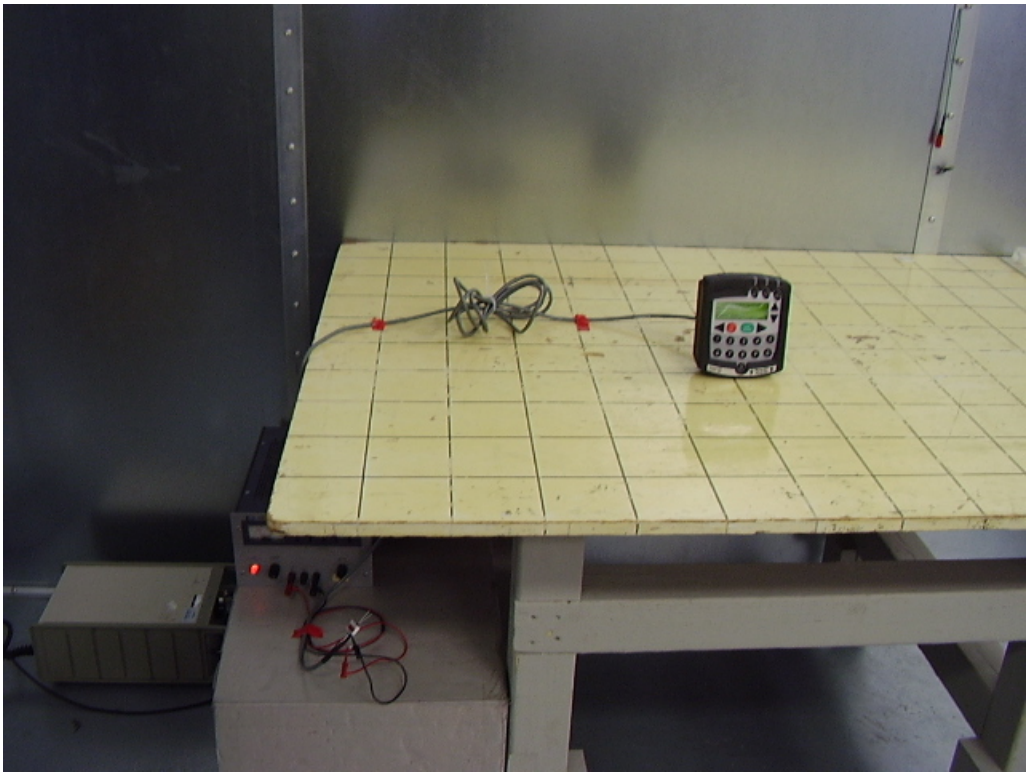


EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE: 15.207

6.1 Test Setup

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, Issue 6). 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).

6.2 Test Setup Photo(s) – Conducted Emissions Test



6.3 Test Procedure

The EUT was investigated in normal and continuous 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.

6.4 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 stored in memory and allows direct readings to be taken.

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
Spectrum Analyzer	Agilent	E4446A	US45300564
LISN	EMCO	3816/2NM	9701-1057
Transient Limiter	HP	119474A	3107A01708

6.5 Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.107 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

6.6 FCC Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBµV)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

6.7 DATA CHART – CONDUCTED EMISSIONS TEST

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.107 Class B

Manufacturer:	ID Systems					
Date(s) of Test:	October 4th to 11th 2006					
Test Engineer(s):	Abtin Spantman					
Voltage:	120 VAC					
Operation Mode:	Continuous transmit					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
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

		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Measurement (dBµV)	Q-Peak Limit (dBµ V)	Quasi-Peak Margin (dB)	Average Measurement (dBµV)	Average Limit (dBµ V)	Average Margin (dB)
0.158	1	54.8	65.6	10.8	26.5	55.6	29.1
0.192	1	51.9	64.0	12.1	35.3	54.0	18.7
0.248	1	47.5	61.8	14.3	24.4	51.8	27.4
0.158	2	53.2	65.6	12.4	25.8	55.6	29.8
0.196	2	51.7	63.8	12.1	33.7	53.8	20.1
0.237	2	48.3	62.2	13.9	29.0	52.2	23.2

Notes:

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

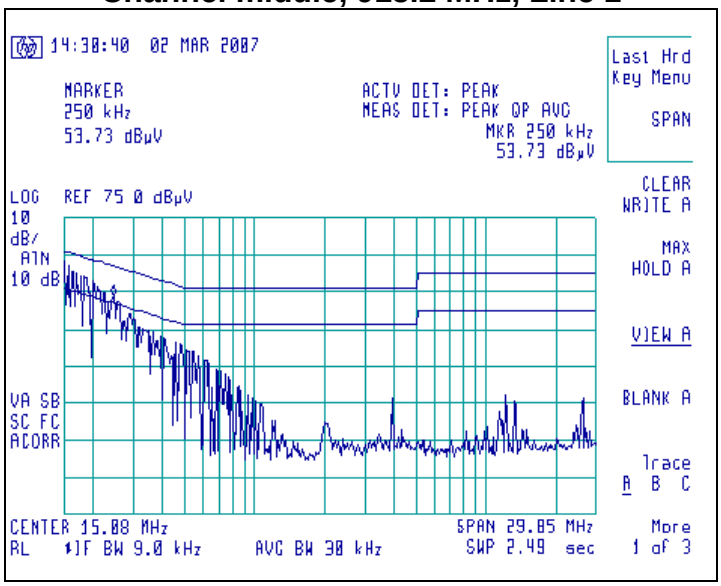
2) The EUT exhibited similar emissions in transmit and receive modes, and across the Low, Middle and High channels tested.

6.8 Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.107.

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

Channel middle, 915.2 MHz, Line 1



Channel middle, 915.2 MHz, Line 2

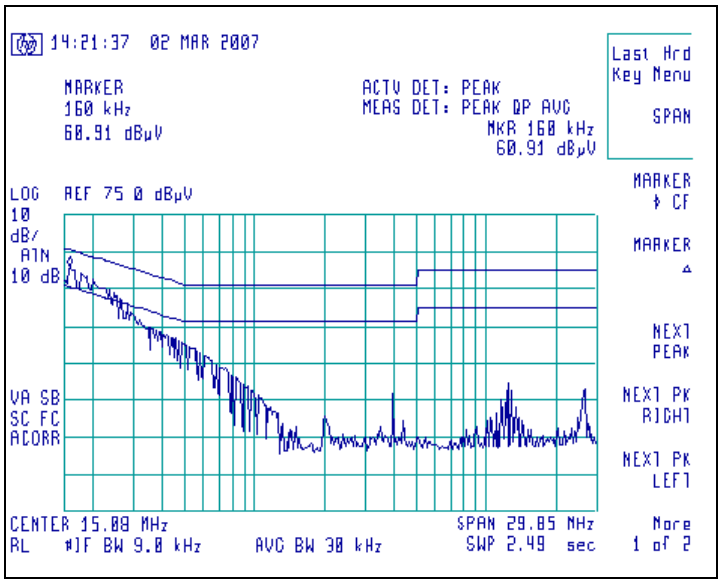


EXHIBIT 7. OCCUPIED BANDWIDTH: 15.247(a)(2)

7.1 Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

7.2 Method of Measurements

Refer to ANSI C63.4 and FCC Procedures (March 23, 2005) for Digital Transmission Systems operating under 15.247.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 100 kHz RBW and VBW=300 kHz.

The bandwidth requirement found in FCC Part 15.247(a)(2) requires a minimum -6dBc occupied bandwidth of 500 kHz. For this portion of the tests, a direct 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 measurements, 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 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 540 kHz, which is above the minimum of 500 kHz.

7.3 Test Equipment List

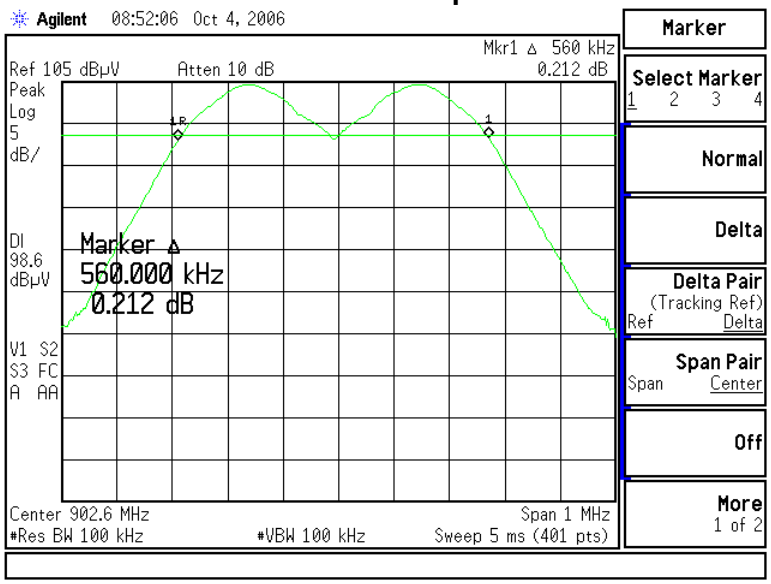
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4407B	US39160256
Spectrum Analyzer	Agilent	E4446A	US45300564

7.4 Test Data

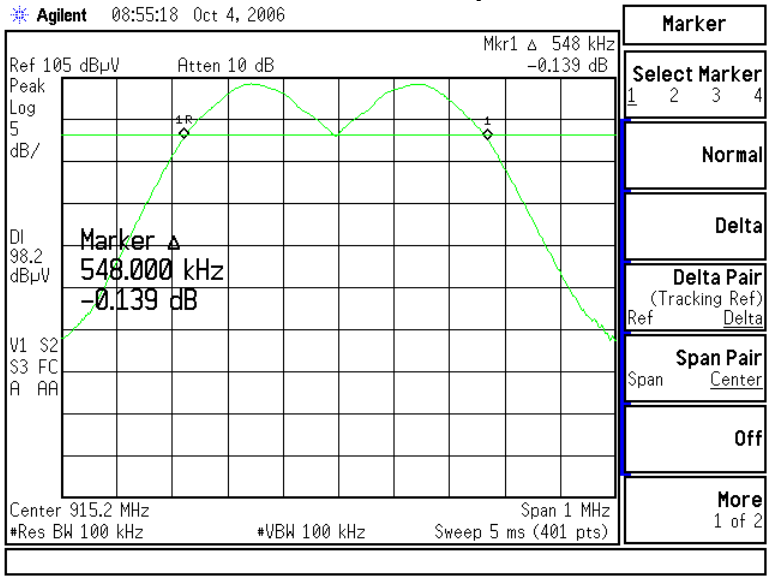
Channel	Center Frequency (MHz)	Measured -6 dBc Occ. BW (kHz)	Minimum -6 dBc Limit (kHz)	Measured -20 dBc Occ.Bw (kHz)
Low	902.6	560	500	805
Middle	915.2	548	500	783
High	927.2	540	500	768

7.5 Screen Captures - OCCUPIED BANDWIDTH

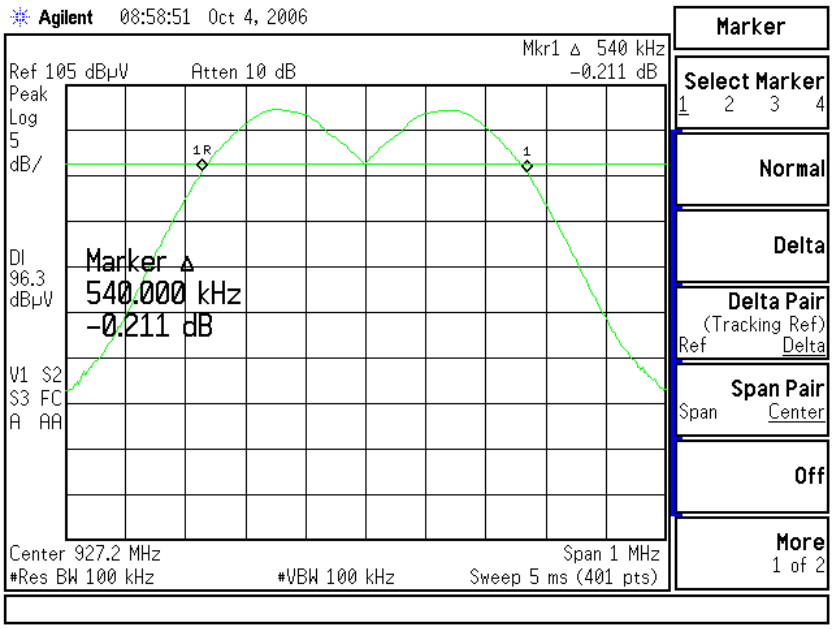
Channel low -6 dBc Occupied Bandwidth



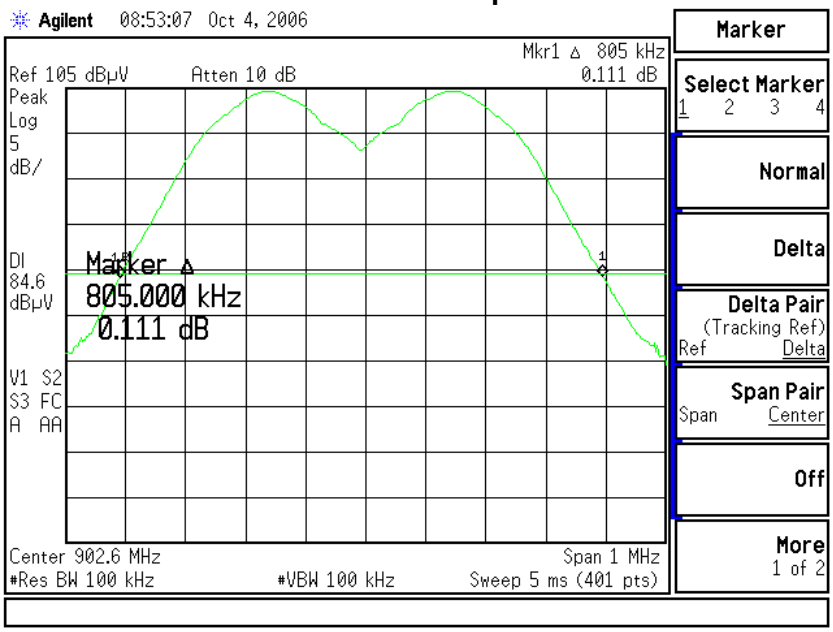
Channel middle -6 dBc Occupied Bandwidth



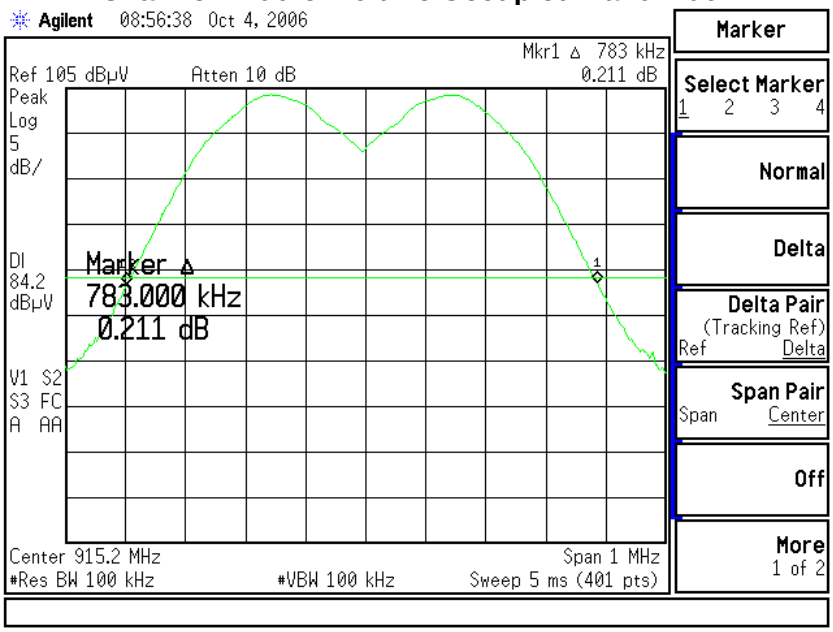
Channel high -6 dBc Occupied Bandwidth



Channel low -20 dBc Occupied Bandwidth



Channel middle -20 dBc Occupied Bandwidth



Channel high -20 dBc Occupied Bandwidth

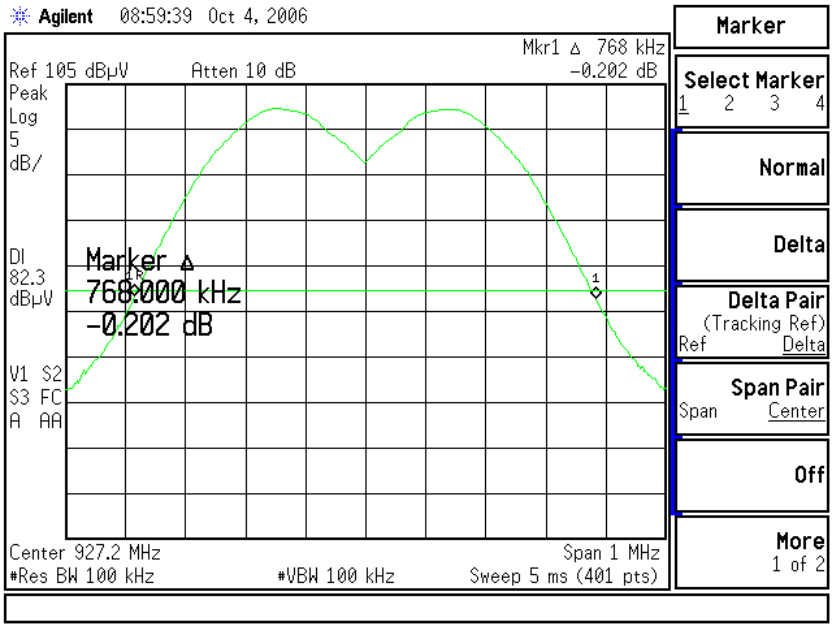


EXHIBIT 8. BAND-EDGE MEASUREMENTS

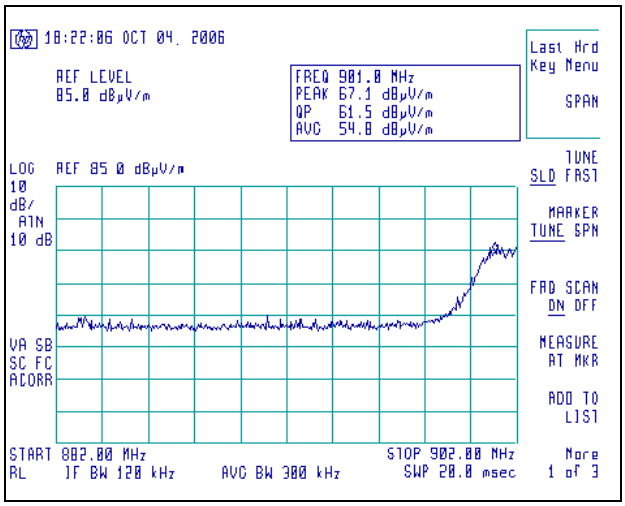
8.1 Method of Measurements

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 2400-2483.5 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 Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

The Upper Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Screen Capture Demonstrating Compliance at the Higher Band-Edge

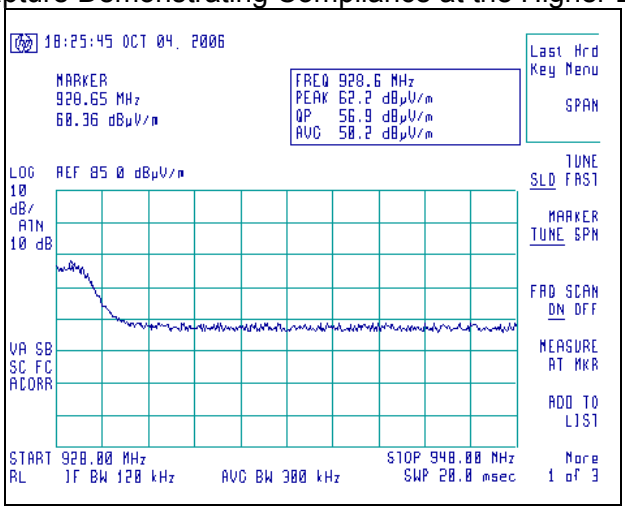


EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

9.1 Method of Measurements

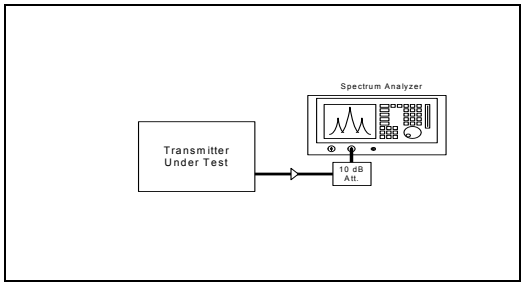
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, there by allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical as a modulation source. The spectrum analyzer was used with resolution and video bandwidths set to 1 MHz, and a span of 10 MHz, with measurements from a peak detector presented in the chart below.

9.2 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Hewlett Packard	E4407B	US39160256	9kHz-26.5GHz

9.3 Test Data

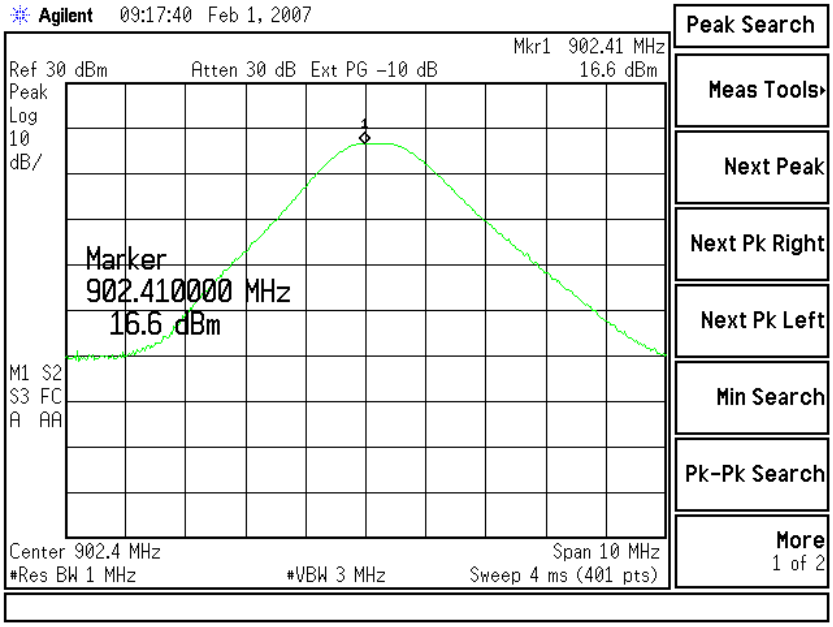
CHANNEL	CENTER FREQ (MHz)	LIMIT (dBm)	MEASURED POWER (dBm)	MARGIN (dB)
Low	902.6	+30 dBm	16.6	13.4
Middle	915.2	+30 dBm	16.7	13.3
High	927.2	+30 dBm	14.4	15.6



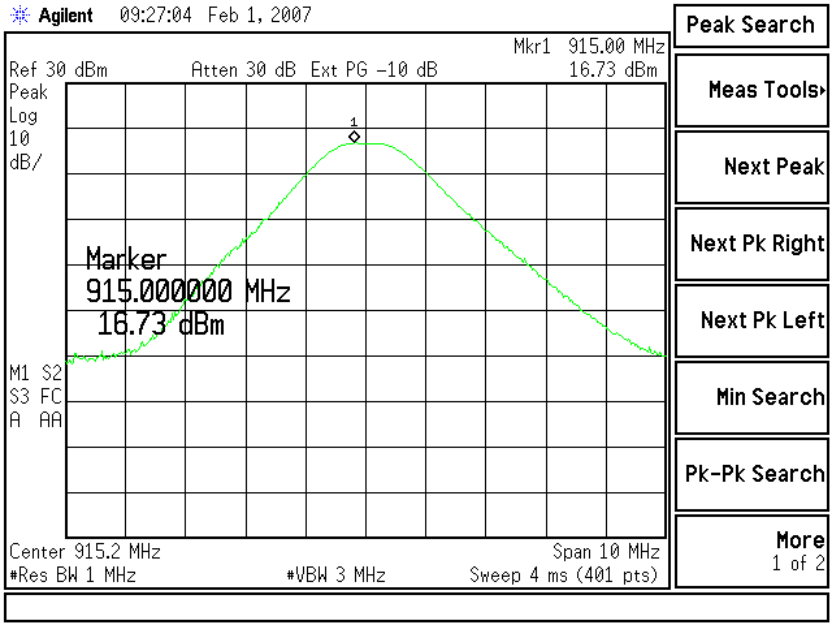
Radiated RF power output (in watts): 0.00845 Watts
Conducted RF Power Output (in Watts): 0.0468 Watts
Declared RF Power Output (in Watts): 0.100 Watts

9.4 Screen Captures – Power Output (Conducted)

Channel Low



Channel Middle



Channel High

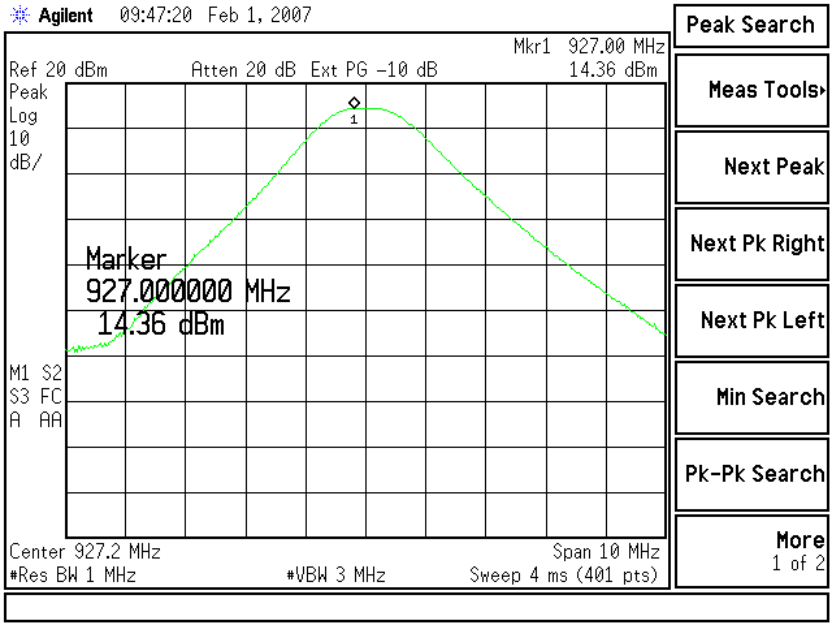


EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

10.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed. The highest density was found to be no greater than 2.93 dBm, which is under the allowable limit by 5.07 dB.

10.2 Test Equipment List

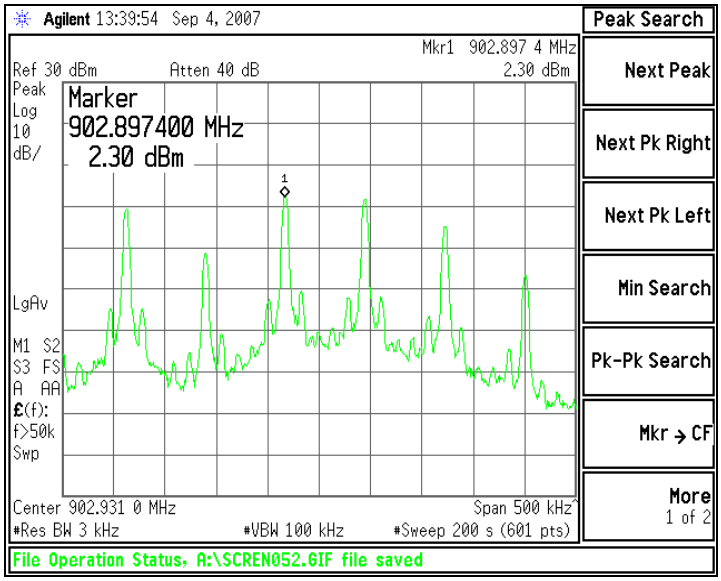
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

10.3 Test Data

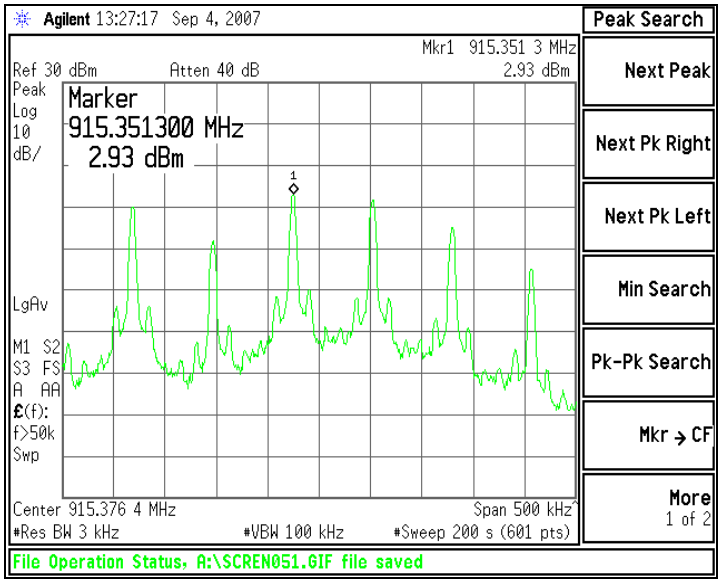
Transmitter Channel	Frequency (MHz)	RF Power Level In 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
1	902.75	2.30	8.0	5.70	Pass
23	915.20	2.93	8.0	5.07	Pass
44	927.79	2.51	8.0	5.49	Pass

10.4 Screen Captures – Power Spectral Density

Channel 1



Channel 23



Screen Captures – Power Spectral Density *(continued)*

Channel 44

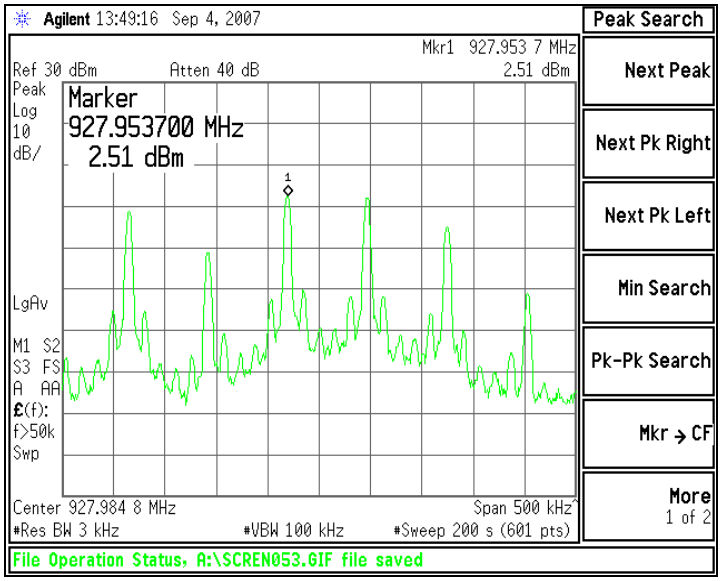


EXHIBIT 11. SPURIOUS RADIATED EMISSIONS: 15.247(d)

11.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at lease 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

In addition, radiated emissions, which fall in the restricted band, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(e)

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in Section 15.35 for limiting peak emissions apply.

FCC 47 CFR 15.205(a) – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 – 0.110	162.0125 – 167.17	2310 – 2390	9.3 – 9.5
0.49 – 0.51	167.72 – 173.2	2483.5 – 2500	10.6 – 12.7
2.1735 – 2.1905	240 – 285	2655 – 2900	13.25 – 13.4
8.362 – 8.366	322 – 335.4	3260 – 3267	14.47 – 14.5
13.36 – 13.41	399.9 – 410	3332 – 3339	14.35 – 16.2
25.5 – 25.67	608 – 614	3345.8 – 3358	17.7 – 21.4
37.5 – 38.25	960 – 1240	3600 – 4400	22.01 – 23.12
73 – 75.4	1300 – 1427	4500 – 5250	23.6 – 24.0
108 – 121.94	1435 – 1626.5	5350 – 5460	31.2 – 31.8
123 – 138	1660 – 1710	7250 – 7750	36.43 – 36.5
149.9 – 150.05	1718.8 – 1722.2	8025 – 8500	Above 38.6
156.7 – 156.9	2200 – 2300	9000 – 9200	

FCC 47 CFR 15.209(a) Field Strength Limits within Restricted Frequency Bands

Frequency (MHz)	Field Strength Limits (microvolts/m)	Distance (Meters)
0.009 – 0.490	2,400 / F (kHz)	300
0.490 – 1.705	24,000 / F (kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

Calculation of Radiated Emission Measurements

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

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 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 -50 dBc of the fundamental level for this product.

11.2 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Hewlett Packard	E4407B	US39160256	9 KHz To 26.5 GHz

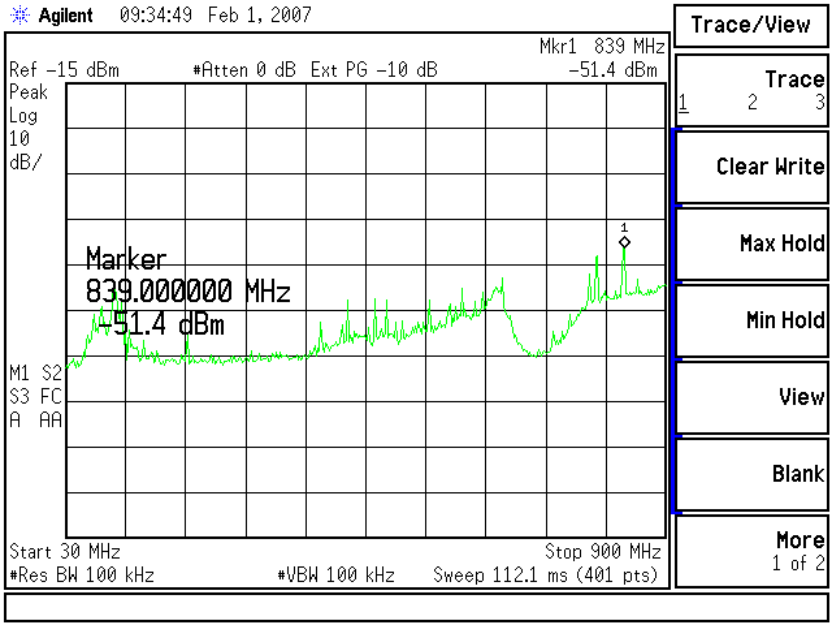
11.3 Test Data

	Channel Low	Channel Middle	Channel High
Fundamental	+ 12.8(dBm)	+ 13.1 (dBm)	+ 10.7 (dBm)
2nd Harmonic	- 36.2 (dBm)	- 38.0 (dBm)	- 45.0 (dBm)
3rd Harmonic	- 35.6 (dBm)	- 36.6 (dBm)	- 43.9 (dBm)
4th Harmonic	- 71.7 (dBm)	- 71.7 (dBm)	- 73.9 (dBm)
5th Harmonic	Note (1)	Note (1)	Note (1)
6th Harmonic	Note (1)	Note (1)	Note (1)
7th Harmonic	Note (1)	Note (1)	Note (1)
8th Harmonic	Note (1)	Note (1)	Note (1)
9th Harmonic	Note (1)	Note (1)	Note (1)
10th Harmonic	Note (1)	Note (1)	Note (1)

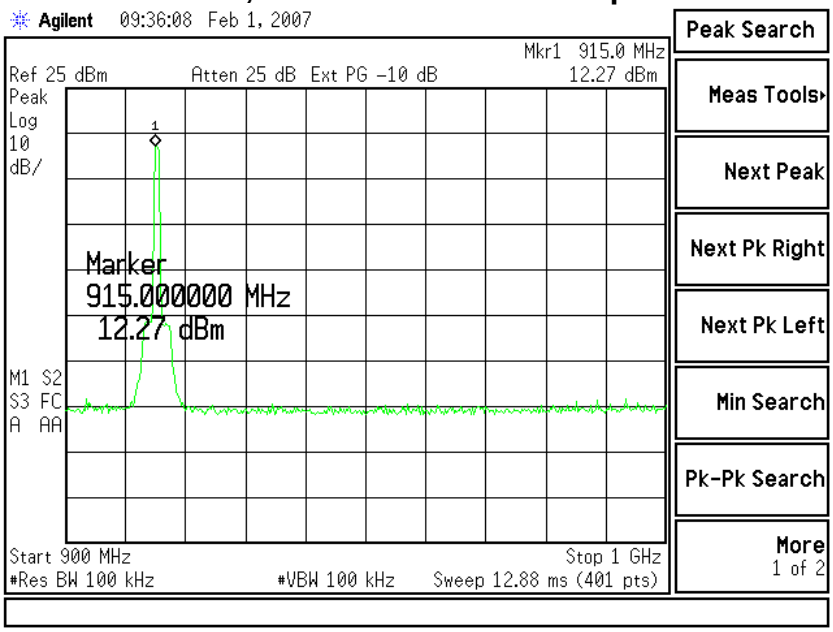
Notes:
(1) Measurement at system noise floor.

11.4 Screen Captures – Spurious Radiated Emissions

Channel Middle, shown from 30 MHz up to 900 MHz



Channel Middle, shown from 900 MHz up to 1000 MHz



Channel Middle, shown from 1000 MHz up to 10000 MHz

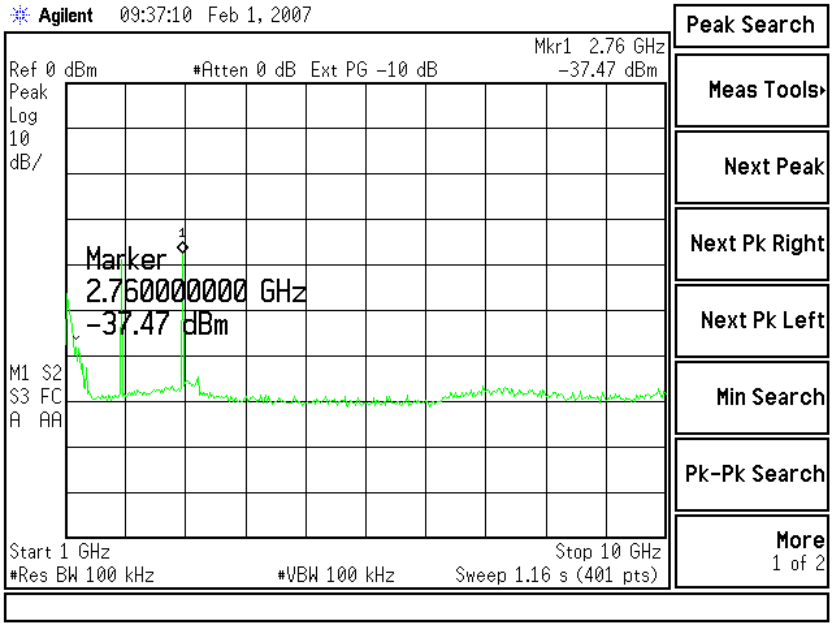


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=10 kHz settings while the voltage was varied.

	DC Voltage Source		
	5.44 VDC	6.40 VDC	7.36 VDC
Channel Low	902592500(Hz)	902592500 (Hz)	902592500 (Hz)
Channel Middle	915195800(Hz)	915195800 (Hz)	915195800 (Hz)
Channel High	927198300(Hz)	927198300 (Hz)	927198300 (Hz)

The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=1 MHz setting while the voltage was varied.

	DC Voltage Source		
	5.44 VDC	6.40 VDC	7.36 VDC
Channel Low	16.5(dBm)	16.6(dBm)	16.6(dBm)
Channel Middle	16.5(dBm)	16.7(dBm)	16.7(dBm)
Channel High	14.3(dBm)	14.4(dBm)	14.4(dBm)

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

At the extreme temperature settings, a wide frequency sweep was also investigated, with minimum and maximum input voltages, to ensure that no unexpected anomalies have occurred.

No anomalies were noted, in the measured transmit power, varying less than 0.2 dB, during the voltage variation tests.

EXHIBIT 13. CHANNEL PLAN AND SEPARATION

Not Applicable for DTS

EXHIBIT 14. MPE CALCULATIONS

The following MPE calculations are based on the LDA 8220D muRata chip antenna, with a measured ERP of104.5 dBµV/m at 3 meters, and conducted RF power of +16.7 dBm as presented to the antenna. The gain of this antenna, based on the data sheet is 1.15dBi.

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:	16.70	(dBm)
Maximum peak output power at antenna input terminal:	46.774	(mW)
Antenna gain(typical):	1.15	(dBi)
Maximum antenna gain:	1.303	(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:	0.012126	(mW/cm^2)
Maximum allowable antenna gain:	18.2	(dBi)
Margin of Compliance at 20 cm =	17.1	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	7/26/06	7/26/07
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	7/20/06	7/20/07
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
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	2/01/06	2/01/07
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(s)

muRata

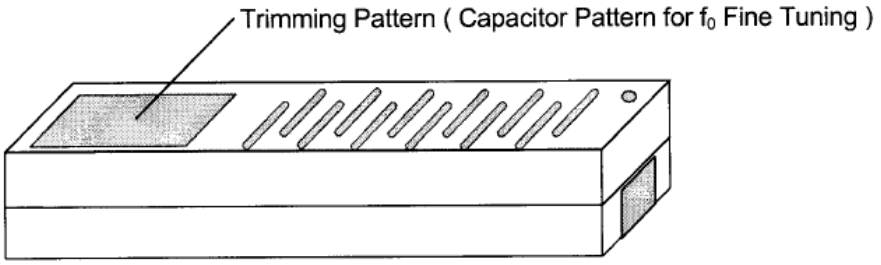
LDA8220D (9.5x2.0x2.0)

♦ Promotion Strategy: To standardize chip size to this 9.5 x 2.0 x 2.0 (LDA82**) for product versatility and production ease.

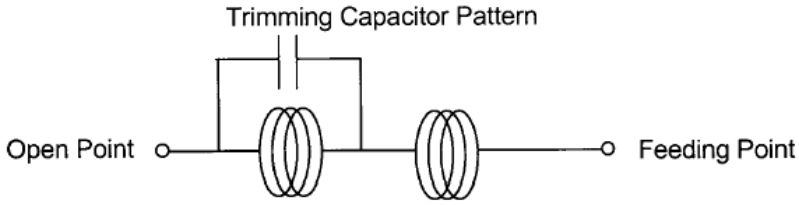
Features

1. Non-GND Type Antenna. λ/4 Resonance Linear Antenna.

(Similar to LDA36D, LDA42D, LDA43D)



(Equivalent Structure)



2. Small and Light Weight. (for comparison only)

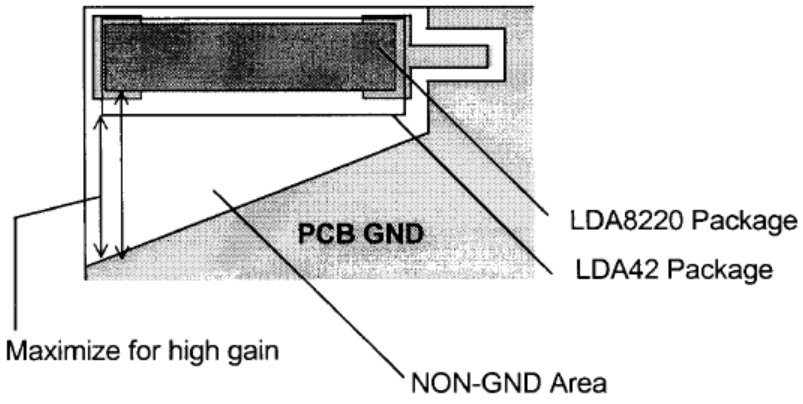
	LDA8220D	LDA40D	LDA36D
Size [mm]	9.5x2.0x2.0	8.0x5.0x2.5	6.3x5.0x1.5
Weight [mg]	120	300	150

3. Low Frequency (800MHz~)

Single Coil Structure (Lower Limit :1200MHz) ▪ Double Coil Structure (Lower Limit :800MHz)

4. High Gain (Equal to Gain of LDA42D) (For comparison only)

	LDA8220D		LDA42D	
	800MHz Band	1500MHz Band	800MHz Band	1500MHz Band
Bandwidth [MHz] (VSWR<3)	54.4	67.0	47.6	61.5
MAX. Gain [dBd]	-1.0	-1.7	-1.0	-1.6
Total Ave. Gain [dB]	-1.7	-4.2	-1.7	-4.1

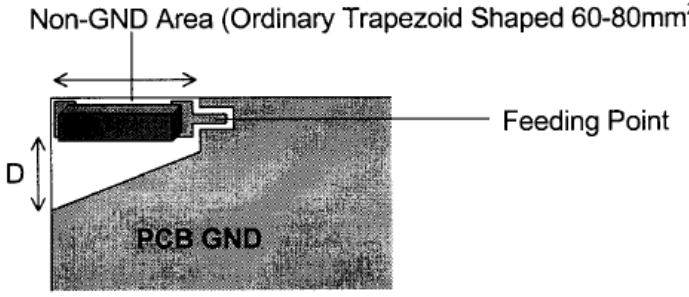


The principle for achieving high gain using a chip antenna is to locate the open terminal (linear side of helix) far from any ground pattern. LDA8220's open terminal is farther from the GND than LDA42D because its width is thinner; thus, the distance from ground is greater than the wider chip antennas.

Though an antenna's gain is typically dependant upon the antenna size, LDA8220's gain is equal to LDA42D, LDA40D, and LDA36D, because of the distance difference between the open terminal and the GND. The distance between the side of the antenna and ground is increased due to the thinner antenna. So, even though the antenna is smaller, the increased separation from ground allows the gain to be the same as the bigger LDA antennas.

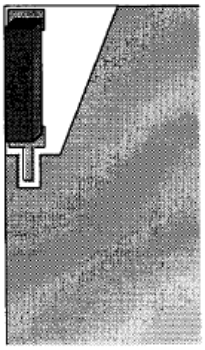
Mounted Arrangement and Orientation

1. Horizontal Arrangement

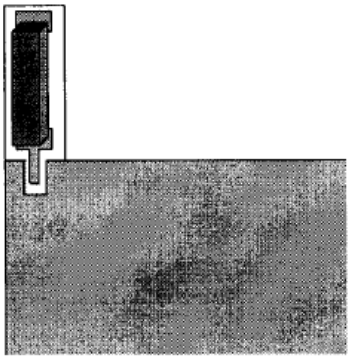


Maximize D for best performance.

2. Vertical Arrangement



3. Extended



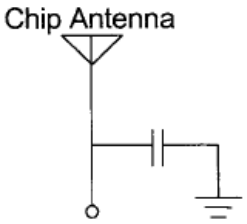
(*) To achieve good chip antenna efficiency, the chip is mounted at corner area in PCB.

(**) Using the chip antenna as a sub antenna in a diversity system, the chip is in horizontal or vertical oriented.

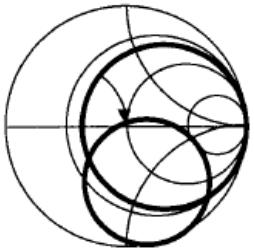
(***) When application requires high gain like a main antenna the extended position is best.

Impedance Matching Method

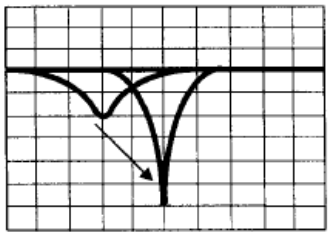
1. Using Shunt Capacitor



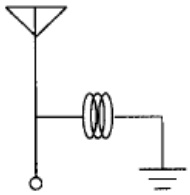
Smith Chart



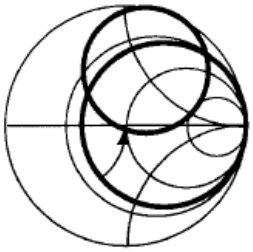
Return Loss



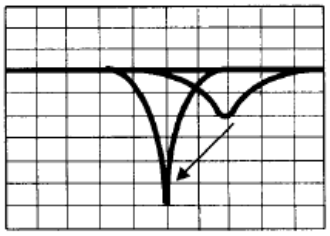
2. Using Shunt Coil



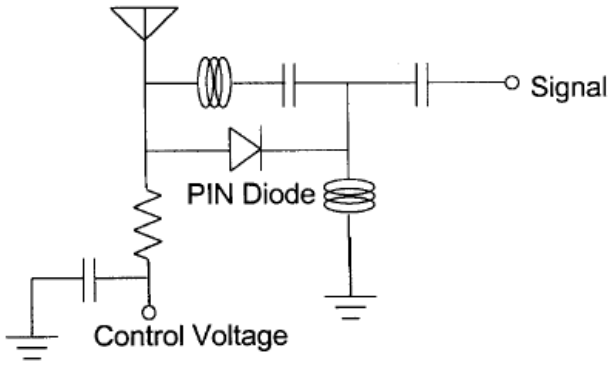
Smith Chart



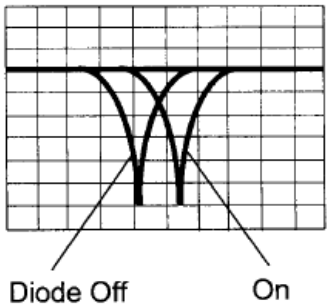
Return Loss



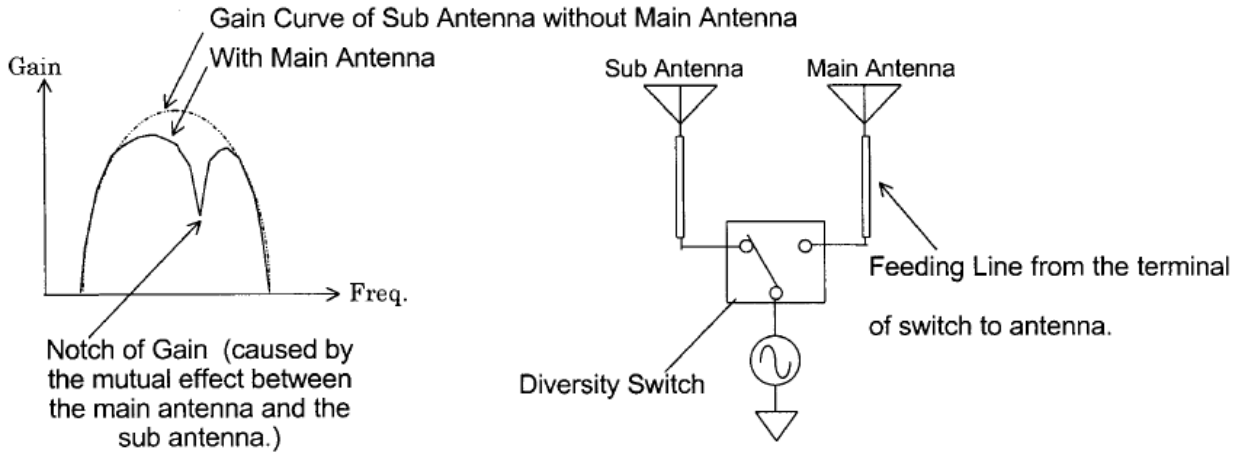
3. Frequency Switching Circuit (For Example, Frequency Switching System in EPDC800)



Return Loss



Technique of Diversity System



A notch in the gain curve can be achieved by adjustment of the resonant frequency of the unfeeding antenna by adjusting the electrical length of the feeding line to the unfeeding antenna. By shortening the electrical length of the feeding line to the unfeeding antenna, the notch frequency can be made higher. By extending the electrical length of the feeding line to the unfeeding antenna, the notch frequency can be made lower. Thus, the notch frequency is adjusted out of the band by tuning the electrical length of the feeding line to the unfeeding antenna. A delay line or L-C circuit can be used in place of tuning the electrical length of the feeding line.

Appendix C

Firmware and Setup Instructions

For testing, ENTER “COMM” menu for all settings.

To change Frequency:

- Press ‘right’ arrow key twice for ‘MYFREQ’.
- Press ‘Enter’
- Scroll up or down using ‘up’ or ‘down’ keys.
- Press ‘right’ arrow to move asterisks to ‘SET’
- Frequency will be displayed in upper right.
- Press ESC to get back to main menu

To change Into Transmit mode:
If in “COMM” menu,
Press ‘right’ arrow key until ‘modulate’

- For CW: Press ‘right’ arrow key twice and enter key on “CW ON”
    - The display will say “TX ON”
- For modulation: Press ‘right’ arrow key twice and press ‘enter’ key on “MOD ON”
    - The display will say “Modulated ON!”
- To enter Receive mode (default mode on power up).
    - Press either “MOD OFF” or “TX OFF” depending on state.

To adjust power:
Under “COMM” menu, press ‘right’ arrow key 4 times and on “OUTPUT POWER” use ‘up’ or ‘down’ keys to choose power levels and ‘enter’ to activate it.