LS Research, LLC
W66 N220 Commerce Court ● Cedarburg, WI 53012 ● USA
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

ENGINEERING TEST REPORT # 308223 TX v2

Project # C-337

Compliance Testing of:
Gateway
Model # GWY-8

Test Date(s):
May 15, 19-22 & June 1, 2008

Prepared For:
Tendril Networks, Inc.
5700 Flatiron Pkwy
Suite 5700D
Boulder, CO 80301

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz

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

Signature: Date: Sept. 4, 2008

Test Report Reviewed by:	**Tested by:**
Teresa A. White, Quality Manager	Laura Bott, EMC Engineer
Signature: Teresa A. White	Signature:
Date: Sept. 4, 2008	Date: Sept/ 4, 2008

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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 2400 MHz – 2483.5 MHz
Test Procedures:	Both conducted and radiated emissions measurements were performed 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 from 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:	**Tendril Networks, Inc.**
Address:	**5700 Flatiron Pkwy** **Suite 5700D** **Boulder, CO 80301**
Contact Person:	**Chris Dalla** **303.894.3106** **chris@tendrilinc.com**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	Gateway
Model Number:	GWY-8
Serial Number:	08190377

2.3 ASSOCIATED ANTENNA DESCRIPTION

2.4 CW-RCL *Antenna Factor*
Center Frequency: 2.45 GHz
Bandwidth: 120 MHz
Wavelength: ½ wave
VSWR: <1.7 typ. at center
Impedance: 50 ohms
Typical Gain: 2.9 dBi
Connector: RP-SMA

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	2400-2483.5
RF Power in Watts	0.10069 Watts
Conducted Output Power (in dBm)	20.03 dBm
Field Strength (and at what distance)	122.5 dBµV/m @ 3 meters
Occupied Bandwidth (99% BW)	2.658 MHz
Type of Modulation	O-QPSK
Emission Designator	2M66G1D
EIRP (in mW)	533.33 mW
Transmitter Spurious (worst case)	66.26 dBµV/m @ 1m
Frequency Tolerance %, Hz, ppm	100 ppm
Microprocessor Model # (if applicable)	AT91RM9200
Antenna Information	
Detachable/non-detachable	Detachable
Type	Whip
Gain (in dBi)	2.9 dBi
EUT will be operated under FCC Rule Part(s)	FCC Title 47§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: 0 %
- Standard used for evaluation: OET 65
- Measurement Distance: 3 m
- RF Value: 1.4289 ☒ V/m ☐ A/m ☐ W/m^2
  ☒ Measured ☐ Computed ☐ Calculated

2.5 PRODUCT DESCRIPTION

The module is a Sensor Network Adapter with Ethernet and USB Interfaces. The adapter extends the capabilities of Daintree's Sensor Network Analyzer (SNA) software. It works with Zigbee networks as a capture device, but is versatile enough to join live networks to passively monitor, actively poll, and commission devices. The module provides active analysis under the control of the SNA. The adapter will join a Zigbee or IEEE 802.15.4 network, interact with other devices on it, and gain access to information not available through passive sniffing alone. The module can also function as a commissioning tool. It is able to commission devices over-the-air and perform other tasks including service discovery, bindings, and over-the-air-firmware upgrades. Multiple modules can be used to capture an entire network. The SNA will synchronize time-stamping to enable a single time-correlated view of the entire network.

The USB mode is used for quickly setting up and troubleshooting with a single adapter and a PC running the SNA software.

The Ethernet connection allows analysis of large dispersed networks. The wireless bridge will allow placement in remote locations and areas not wired with Ethernet.

EUT Photos

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	20-25°C
Humidity:	30-60%
Pressure:	86-106 kPa

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)**

Power reductions on channels as follows:
1a: -28
19: -12
18: -9

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 (2007), Issue 7, 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, where the measurement antenna is 3 meters from the EUT radiating element.

The EUT was tested in continuous transmit mode. Power was supplied to the EUT by a wall wart plugged into the 120 VAC mains. The unit has the capability to operate on 16 channels, controllable via connecting the board to an Ember programmer with a network connection.

The radiated emissions limits for intentional radiators, denoted in FCC §15.209 apply at a 3 meter distance. Measurements above 4 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 (2405 MHz), middle (2440 MHz) and high (2480 MHz) to comply with FCC § 15.35.

5.2 Test Procedure

Radiated Emissions measurements were performed on the EUT from 30 - 1000 MHz in a 3 meter Semi-Anechoic, FCC listed Chamber. The radiated RF emission levels were manually noted at discrete turntable azimuths and measurement antenna heights, corresponding to peak emission levels at various frequencies. 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 rotating the EUT 360°, and raising and lowering the antenna between 1 and 4 meters, using both horizontal and vertical antenna polarities.

When measuring the harmonics, the high channel, whose power is reduced by the greatest amount to meet band edge compliance, was set to full power. Because the harmonics of the high channel at full power met all limits, it is assumed that when the channel is set to the reduced power, the harmonics will maintain compliance.

The EUT was tested in one fixed position, with two antenna positions: vertical (antenna bent 90°) and horizontal (antenna straight), to find the highest emission levels.

5.3 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 List

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

5.4 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 (2007), Issue 7, Annex 8 (section 8.2). The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 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, 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 dBμV/m at 3 meters
54.0 + 9.5 = 63.5 dBμV/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 dBμV/m at 3 meters
54.0 + 20 = 74 dBμV/m at 0.3 meters

5.6 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 25000 MHz

Manufacturer:	Tendril						
Date(s) of Test:	May 15, 21, 22, 26, and June 1, 2008						
Test Engineer(s):	Laura Bott						
Voltage:	120 VAC						
Operation Mode:	Normal, continuous transmit, modulated						
Environmental Conditions in the Lab:	Temperature: 20 – 25˚C Relative Humidity: 30 – 60 %						
EUT Power:	√	Single Phase 120 VAC		3 Phase ___VAC			
		Battery		Other:			
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)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
37.4	1.00	0	38.6	40.0	1.4	Vertical	Vertical
47.8	1.00	0	37.6	40.0	2.4	Vertical	Vertical
99.3	1.00	0	34.6	43.5	8.9	Vertical	Vertical
359.4	1.00	260	28.6	46.0	17.4	Horizontal	Horizontal
419.2	1.00	79	24.7	46.0	21.3	Horizontal	Horizontal
479.2	1.00	260	30.9	46.0	15.1	Horizontal	Horizontal
479.2	1.00	291	29.3	46.0	16.7	Vertical	Horizontal
359.4	1.38	220	30.8	46.0	15.2	Vertical	Horizontal

RADIATED EMISSIONS DATA CHART *(continued)*

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT Antenna orientation
2405	1.16	182	121.20	125	3.8	Horizontal	Horizontal
4810	1	40	39.63	63.5	23.87	Vertical	Vertical
7215	1	0	39.55	111.2	71.65	Vertical	Vertical
9620	1.13	128	62.57	111.2	48.63	Vertical	Vertical
12025	1.21	77	51.05	63.5	12.45	Vertical	Vertical
14430	1	280	62.03	111.2	49.17	Vertical	Horizontal
16835	1.05	30	49.71	111.2	61.49	Horizontal	Horizontal
19240	1	0	60.29	74	13.71	Horizontal	Vertical
21645	1	0	31.66	121.2	89.54	Horizontal	Vertical
24050	1	0	35.53	121.2	85.67	Vertical	Horizontal

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 12:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT Antenna orientation
2440	1.13	210	122.5	125	2.5	Horizontal	Vertical
4880	1	238	45.56	63.5	17.94	Vertical	Vertical
7320	1	41	41.61	63.5	21.89	Vertical	Vertical
9760	1.17	145	63.97	112.5	48.53	Vertical	Horizontal
12200	1.21	93	50.58	63.5	12.92	Vertical	Vertical
14640	1.09	1.04	55.14	112.5	57.36	Vertical	Vertical
17080	1.04	38	53.06	112.5	59.44	Horizontal	Horizontal
19520	1	0	30.28	74	43.72	Vertical	Vertical
21960	1	0	31.64	122.5	90.86	Vertical	Vertical
24400	1	0	35.48	122.5	87.02	Vertical	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 1a:

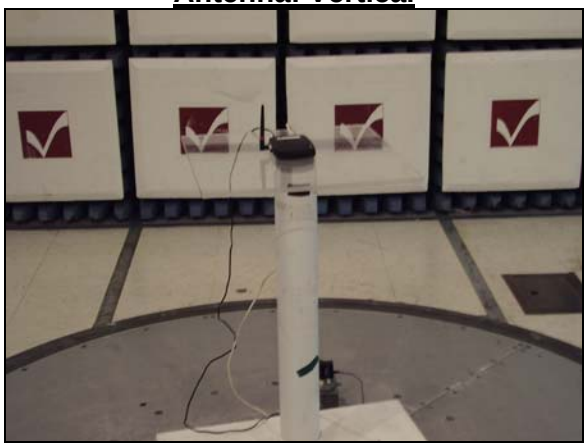
Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT Antenna orientation
2480	1.12	291	93.4	125	31.6	Horizontal	Vertical
4960	1	224	50.29	63.5	13.21	Vertical	Vertical
7440	1	0	40.68	63.5	22.82	Vertical	Vertical
9920	1.06	138	66.23	83.4	17.17	Vertical	Horizontal
12400	1.08	301	57.20	63.5	6.3	Vertical	Horizontal
14880	1	103	53.64	83.4	29.76	Vertical	Horizontal
17360	1.01	325	57.92	83.4	25.48	Horizontal	Horizontal
19840	1	0	41.24	74	32.76	Horizontal	Vertical
22320	1	0	30.34	74	43.66	Vertical	Horizontal
24800	1	0	55.12	93.4	38.28	Vertical	Horizontal

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, and at 0.3 m separation for frequencies between 18 – 25 GHz.
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=3 MHz.

5.7 Test Setup Photo(s) – Radiated Emissions Test

Antenna: Vertical



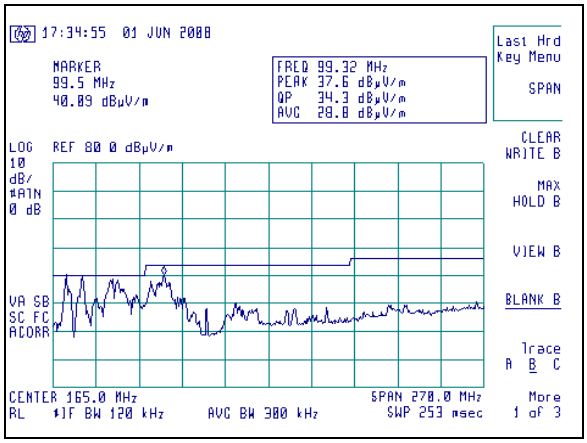
Antenna: Horizontal

5.8 Screen Captures - Radiated Emissions Testing

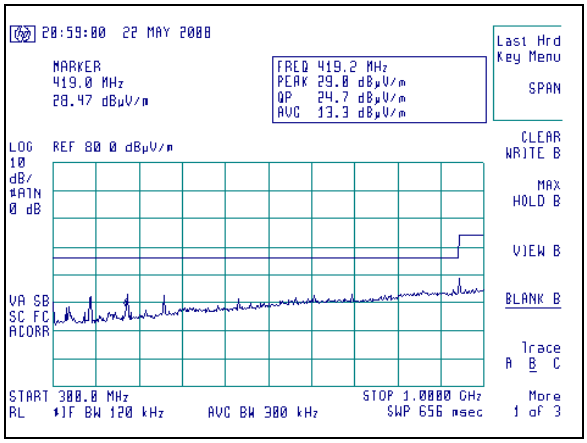
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels b, 12, or 1a, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel 12, Antenna Vertically Polarized, 30-300 MHz, at 3m

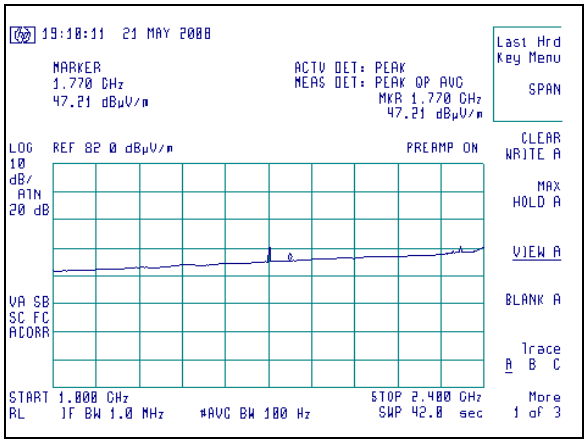


Channel 12, Antenna Horizontally Polarized, 300-1000 MHz, at 3m

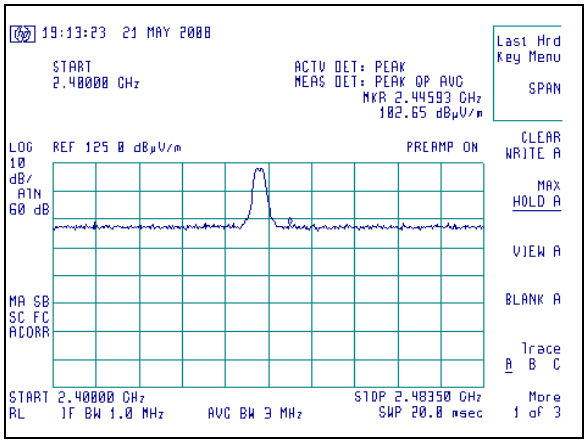


Screen Captures - Radiated Emissions Testing *(continued)*

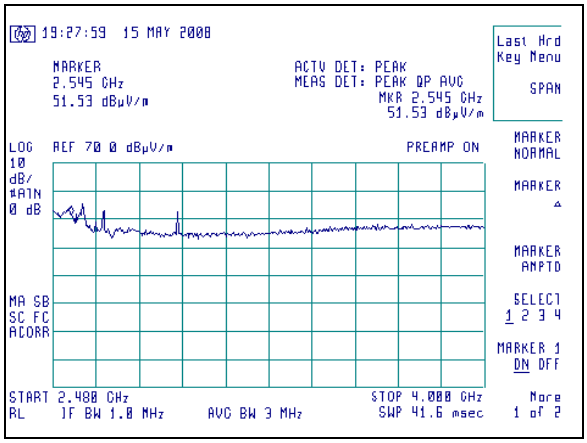
Channel 12, Antenna Vertically Polarized, 1000-2400 MHz, at 3m



Channel 12, Antenna Vertically Polarized, 2400-2483.5 MHz, at 3m

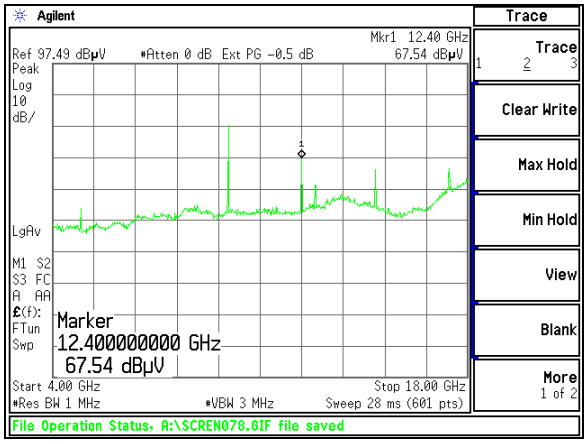


Channel 12, Antenna Vertically Polarized, 2484.0-4000 MHz, at 3m



Screen Captures - Radiated Emissions Testing *(continued)*

Channel 1a, Antenna Vertically Polarized, 4000-18000 MHz, at 1m



Channel 1a, Antenna Horizontally Polarized, 18000-25000 MHz, at 30cm

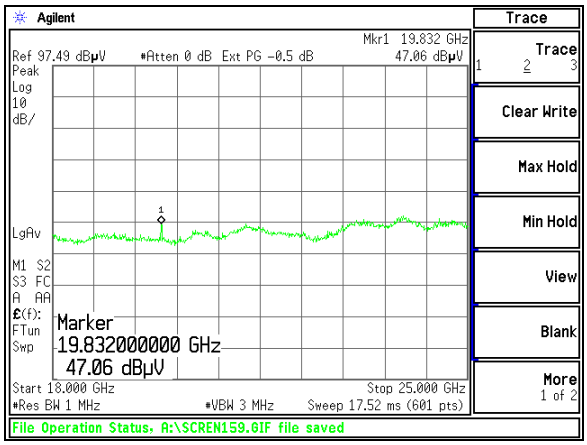


EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE: 15.207

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 7, 2007). 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 120 VAC power supply was fed to the test area via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. 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 Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. Measurements were made from 150 kHz-30MHz. The Intermediate Frequency Bandwidth was set to 9.0 kHz and the Average Bandwidth to 30 kHz, per CISPR 16-1 (2003), Section 1, Table 1. Plots of peak values were captured and are shown below. Quasi-peak and average signal strength values were measured at discrete frequencies; these are denoted in the table in Section 6.5 of this report.

6.3 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 List

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

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.

6.4 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.			

6.5 *TEST DATA CHART CONDUCTED EMISSION*

Frequency Range inspected: 150 KHz to 30 MHz

Test Standard: FCC 15.207 Class B

Manufacturer:	Tendril					
Date(s) of Test:	5/21/2008					
Test Engineer:	Laura Bott					
Model #:	GWY-8					
Serial #:	08190377					
Voltage:	120 VAC					
Operation Mode:	Normal, continuous transmit, modulated mode					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
Test Location:	√	Shielded bench test area				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

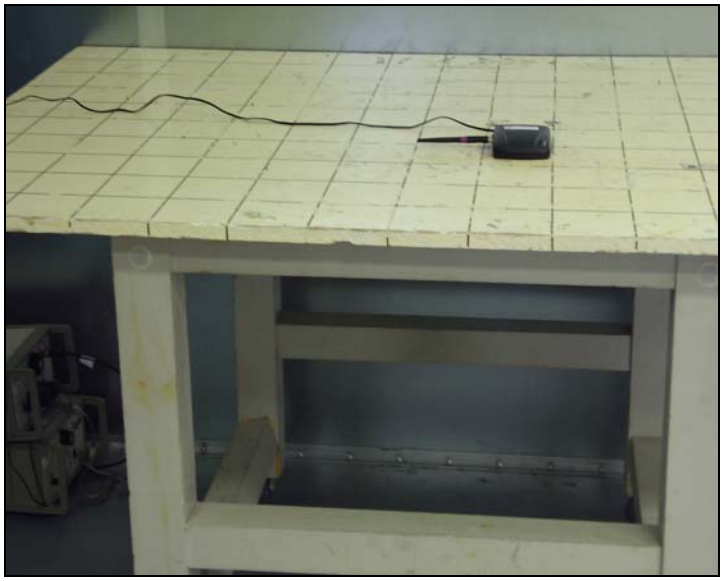
		Quasi-Peak			Average		
Frequency (MHz)	**Line**	**Q-Peak Reading (dBµV)**	**Q-Peak Limit (dBµV)**	**Quasi-Peak Margin (dB)**	**Average Reading (dBµV)**	**Average Limit (dBµV)**	**Average Margin (dB)**
0.201	L1	50.600	63.582	12.982	46.200	53.582	7.382
0.503	L1	48.900	56.000	7.100	41.700	46.000	4.300
0.604	L1	47.800	56.000	8.200	39.800	46.000	6.200
0.705	L1	45.800	56.000	10.200	33.500	46.000	12.500
0.806	L1	49.100	56.000	6.900	39.400	46.000	6.600
0.907	L1	50.400	56.000	5.600	40.800	46.000	5.200
1.008	L1	49.300	56.000	6.700	36.800	46.000	9.200
1.107	L1	52.600	56.000	3.400	40.200	46.000	5.800
1.209	L1	52.900	56.000	3.100	40.500	46.000	5.500
1.306	L1	48.500	56.000	7.500	33.000	46.000	13.000
1.407	L1	46.300	56.000	9.700	33.200	46.000	12.800
0.204	L2	51.200	63.459	12.259	43.300	53.459	10.159
0.504	L2	45.000	56.000	11.000	30.300	46.000	15.700
0.613	L2	44.400	56.000	11.600	31.700	46.000	14.300
0.806	L2	43.700	56.000	12.300	25.100	46.000	20.900
0.918	L2	45.400	56.000	10.600	32.200	46.000	13.800
1.127	L2	45.300	56.000	10.700	26.400	46.000	19.600
1.216	L2	46.500	56.000	9.500	30.800	46.000	15.200

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.

6.6 Test Setup Photo(s) – Conducted Emissions Test

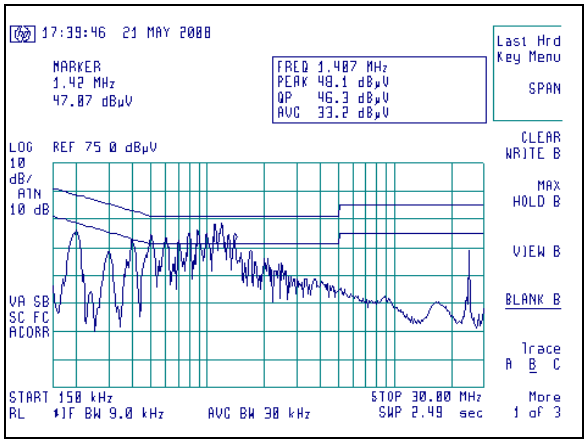


6.7 Screen Captures – Conducted Emissions Test

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 15.207.

The signature scans shown here are from channel 7, chosen as a good representative of channels.

Channel 12, 2440 MHz, Line 1



Channel 12, 2440 MHz, Line 2

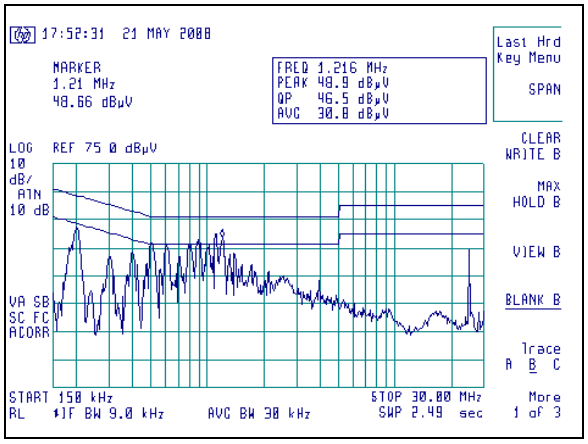


EXHIBIT 7. OCCUPIED BANDWIDTH: 15.247(a)(2)

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.

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 E4447A spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset.

The EUT was configured to run in a continuous transmit, modulated mode. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

Test Data

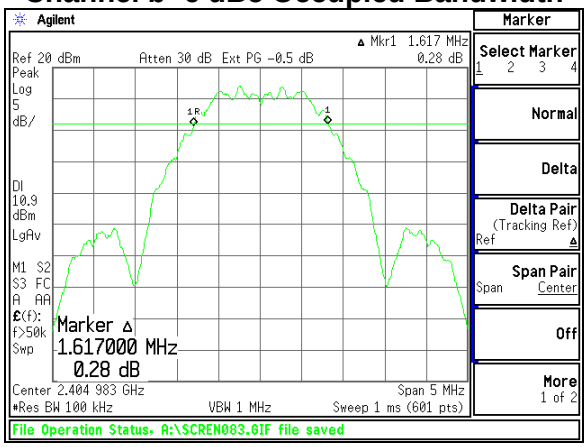
Channel	Center Frequency (MHz)	Measured -6 dBc Occupied Bandwidth (kHz)	Minimum -6 dBc Limit (kHz)	Measured -20 dBc Occupied Bandwidth (kHz)
b	2405	1617	500	2667
12	2440	1600	500	2658
17	2465	1600	500	2650
18	2470	1592	500	2642
19	2475	1600	500	2650
1a	2480	1625	500	2650

7.3 Test Equipment List

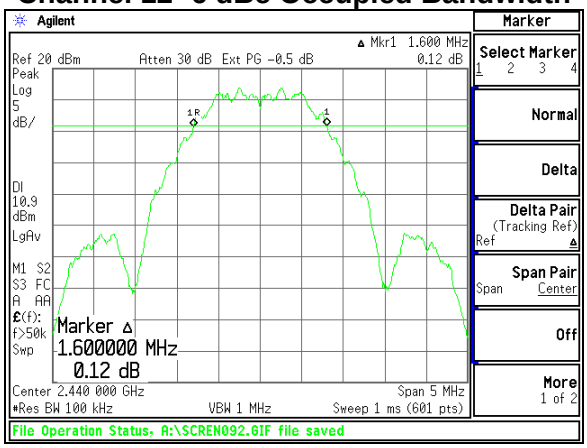
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4407B	US39160256
Spectrum Analyzer	Agilent	E4446A	US45300564

7.4 Screen Captures - OCCUPIED BANDWIDTH

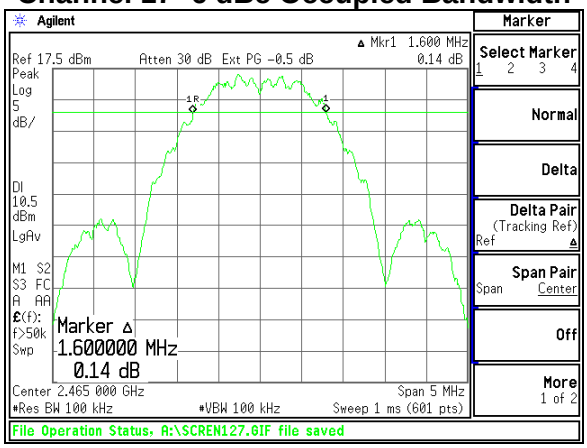
Channel b -6 dBc Occupied Bandwidth



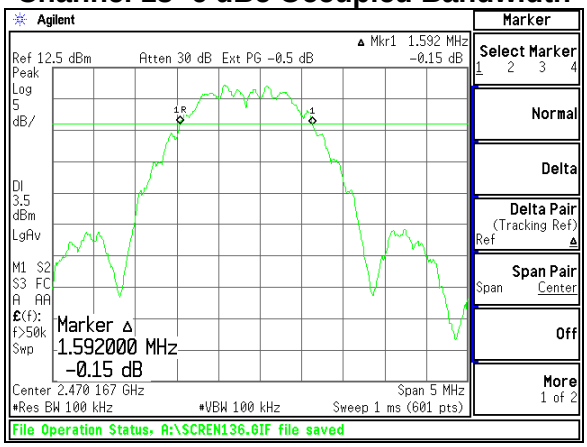
Channel 12 -6 dBc Occupied Bandwidth



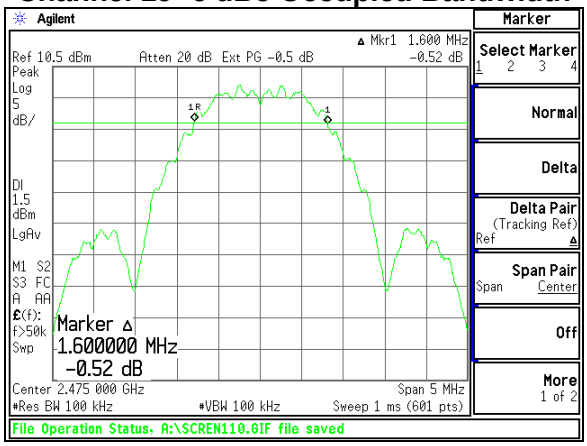
Channel 17 -6 dBc Occupied Bandwidth



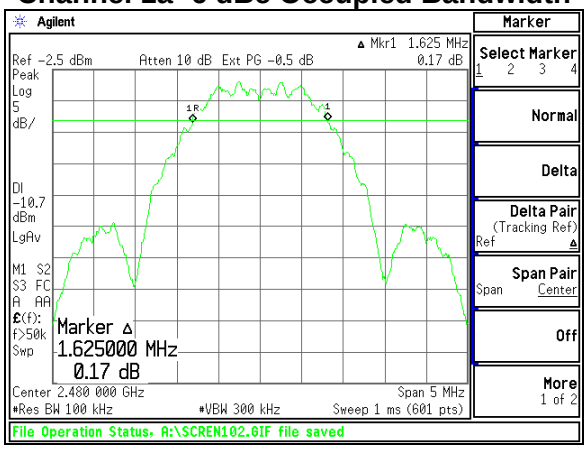
Channel 18 -6 dBc Occupied Bandwidth



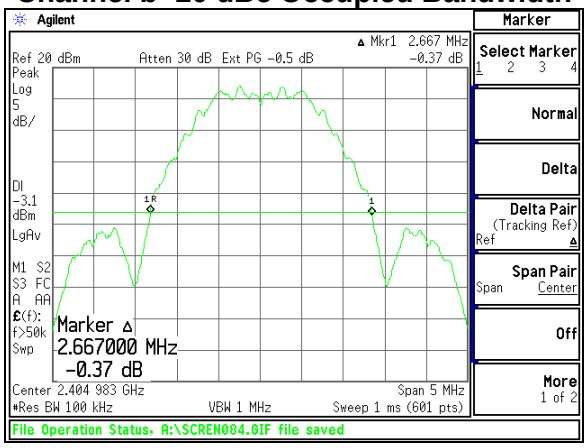
Channel 19 -6 dBc Occupied Bandwidth



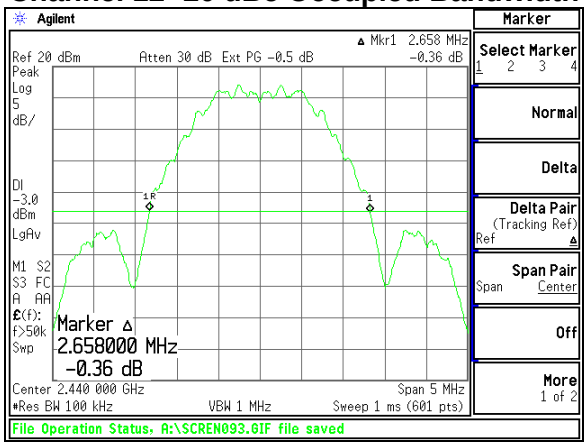
Channel 1a -6 dBc Occupied Bandwidth



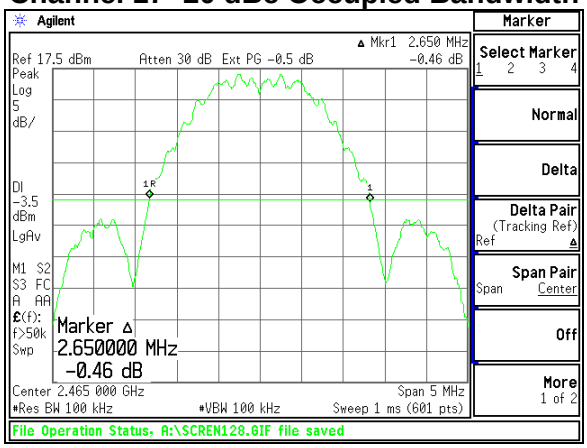
Channel b -20 dBc Occupied Bandwidth



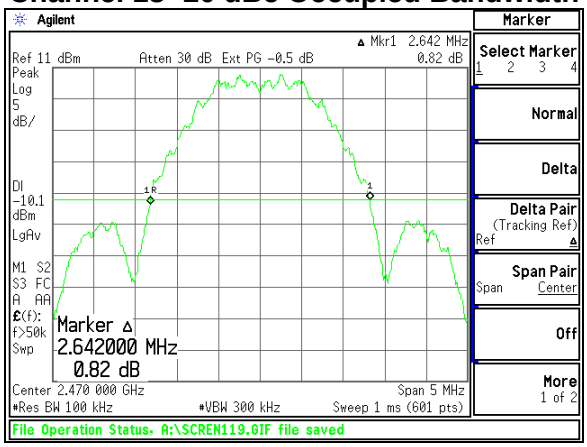
Channel 12 -20 dBc Occupied Bandwidth



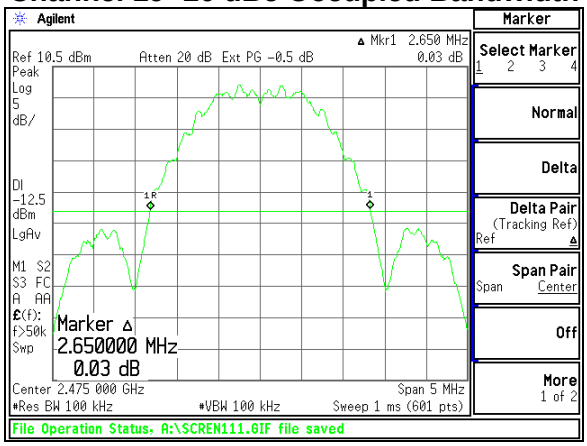
Channel 17 -20 dBc Occupied Bandwidth



Channel 18 -20 dBc Occupied Bandwidth



Channel 19 -20 dBc Occupied Bandwidth



Channel 1a -20 dBc Occupied Bandwidth

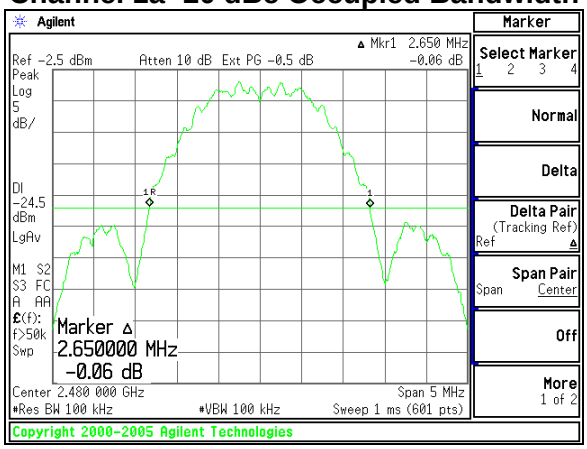


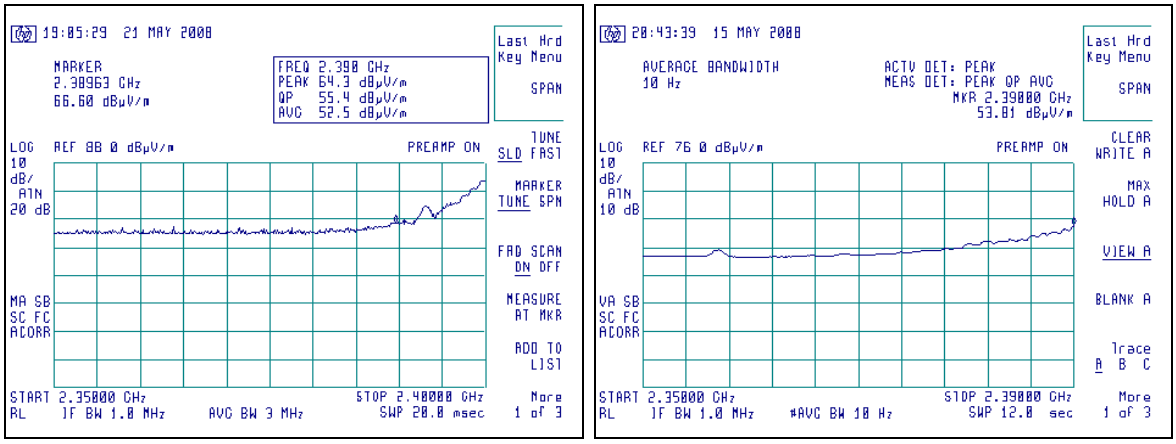
EXHIBIT 8. BAND-EDGE MEASUREMENTS

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.

Lower Band-Edge Limit,
2.39 GHz = +54 dBµV/m at 3m
2.40 GHz = -20 dBc with respect to the peak fundamental radiated emissions.
Upper Band-Edge Limi,
2.4835 GHz =e + 54 dBµV/m at 3m.

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Screen Capture Demonstrating Compliance at the Higher Band-Edge

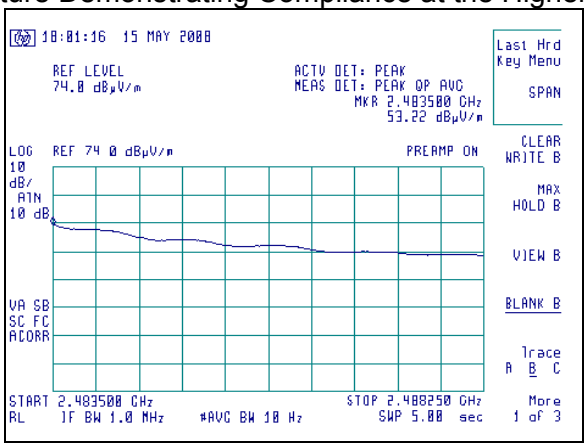


EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

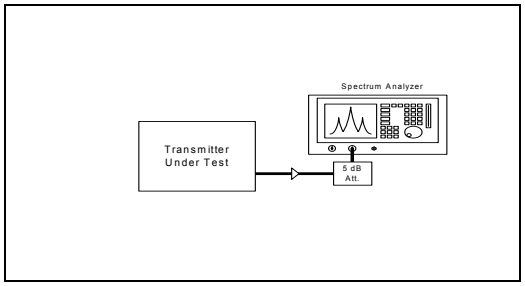
9.1 Method of Measurements

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. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset. The unit was configured to run in a continuous transmit mode. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 5 MHz, with measurements from a peak detector presented in the chart below.

9.2 Test Data

Channel	Center Frequency (MHz)	Measured Power (dBm)	Limit (dBm)	Margin (dB)	Calculated EIRP (dBm)	EIRP Limit (dBm)	Calculated EIRP (mw)
b	2405	19.99	30	10.01	22.89	36.0	194.54
12	2440	20.03	30	9.97	22.93	36.0	196.34
17	2465	20.03	30	9.97	22.93	36.0	196.34
18	2470	13.02	30	16.98	15.92	36.0	39.08
19	2475	10.89	30	19.11	13.79	36.0	23.93
1a	2480	-1.19	30	31.19	1.71	36.0	1.48

(1) EIRP Calculation:
EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi)



Rated RF power output (in watts): 0.1 W

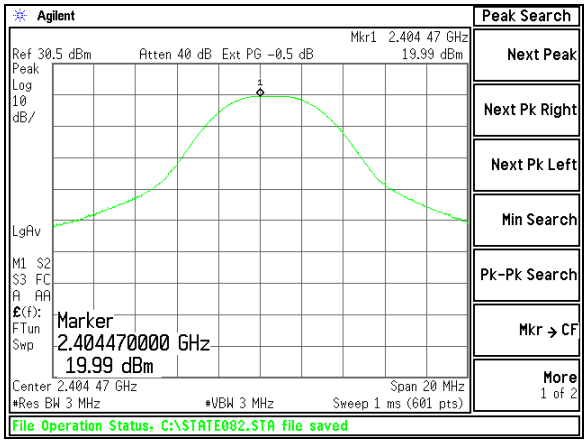
Measured RF Power Output (in Watts): 0.101 W
Declared RF Power Output (in Watts): 0.1 W

9.3 Test Equipment List

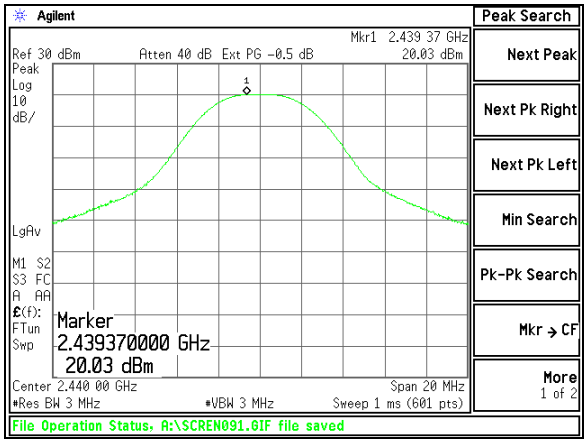
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

9.4 Screen Captures – Power Output (Conducted)

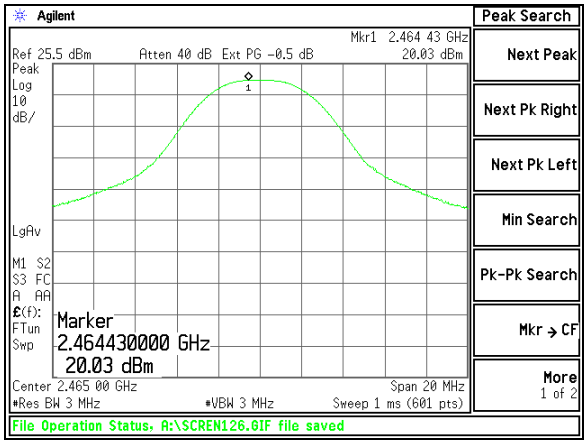
Channel b: 2405 MHz



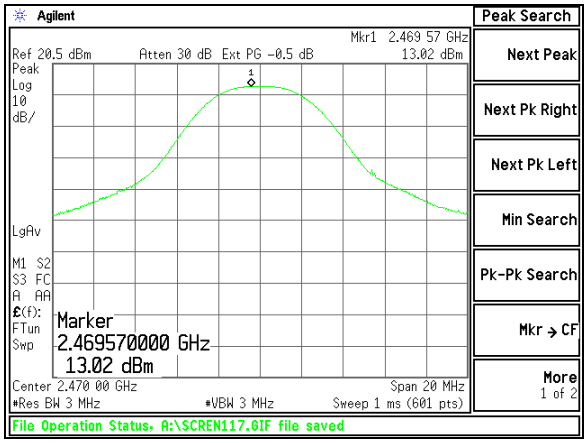
Channel 12: 2440 MHz



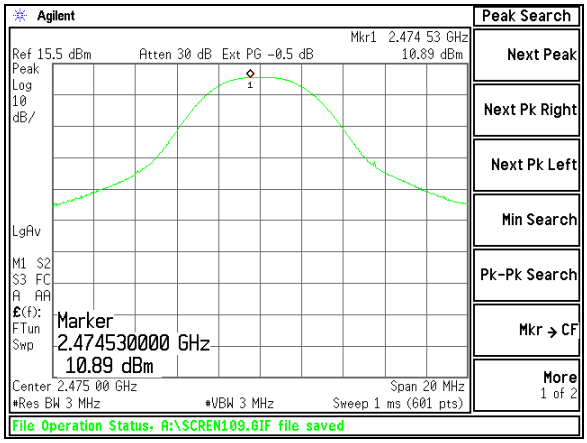
Channel 17: 2465



Channel 18: 2470 MHz



Channel 19: 2475 MHz



Channel 1a: 2480 MHz

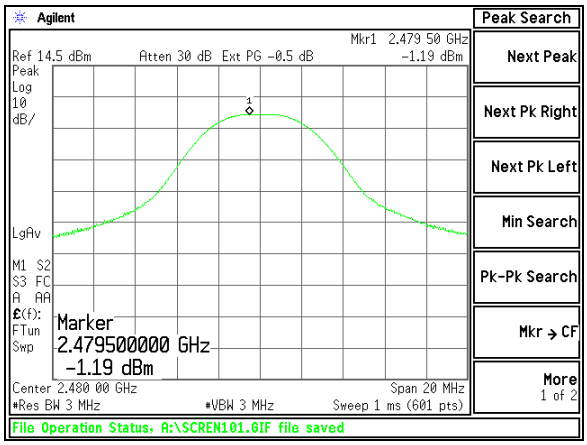


EXHIBIT 10. POWER SPECTRAL DENSITY: 15.247(e)

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 using the utility built into the HP Analyzer. The resultant density was then corrected to a 3 kHz bandwidth.

10.2 Test Equipment List

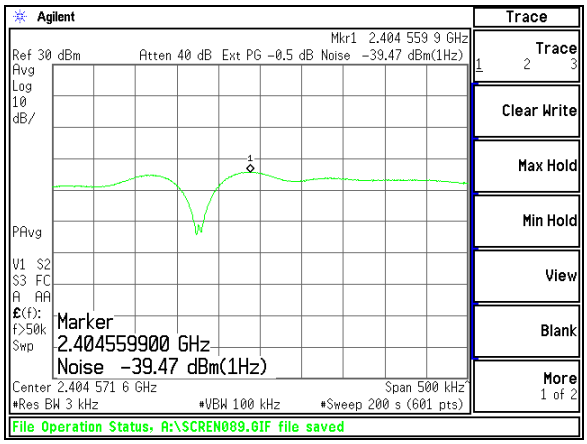
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

10.3 Test Data

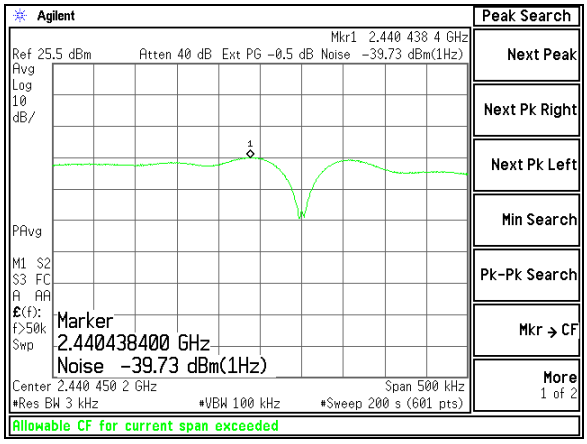
Channel	Center Frequency (MHz)	Measured Channel Power (dBm/1Hz)	3 kHz Correction (dB)	Corrected Power Measurement (dBm/3kHz)	Limit (dBm)	Margin
b	2405	-39.47	34.77	-4.7	8.0	12.7
12	2440	-39.73	34.77	-4.96	8.0	13.0
17	2465	-39.76	34.77	-4.99	8.0	13.0
18	2470	-47.85	34.77	-13.08	8.0	21.1
19	2475	-48.85	34.77	-14.08	8.0	22.1
1a	2480	-60.77	34.77	-26	8.0	34.0

10.4 Screen Captures – Power Spectral Density

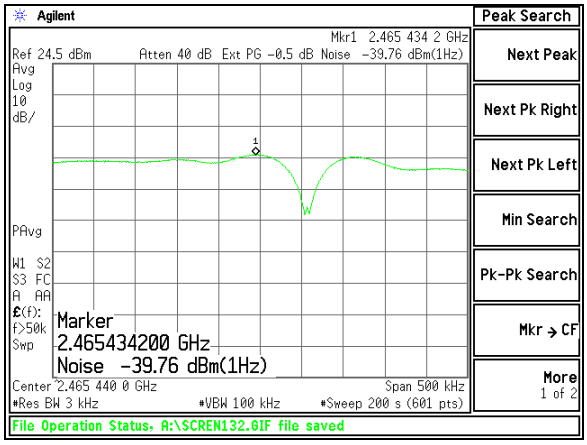
Channel b



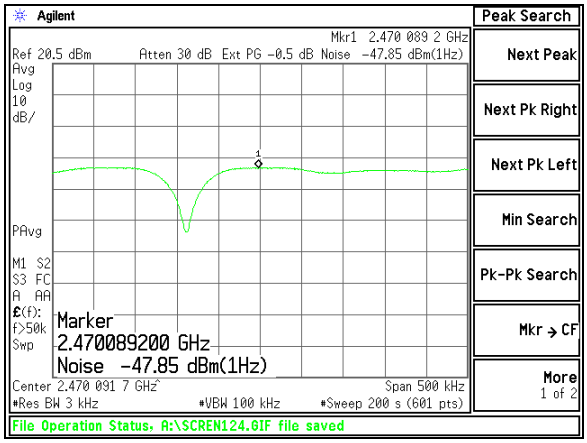
Channel 12



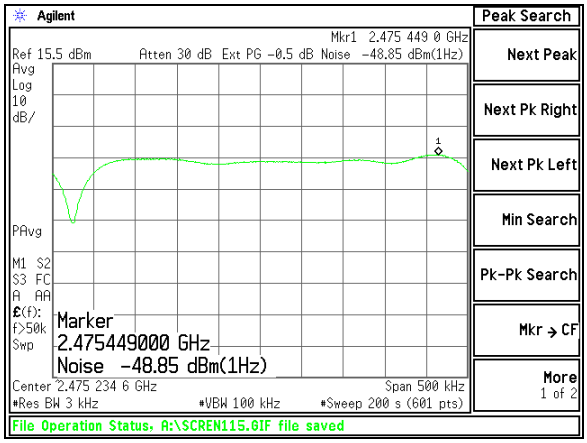
Channel 17



Channel 18



Channel 19



Channel 1a

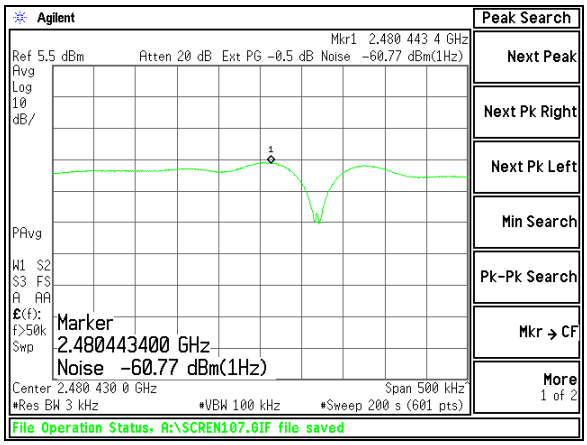


EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

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.

For data from the radiated measurements, please refer to section 5.6 of this report.

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. The cable calibration file was loaded into the spectrum analyzer to compensate for the loss of the cable between the antenna port of the EUT to the spectrum analyzer. A Hewlett Packard model E4446A 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. 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 b	Channel 12	Channel 17	Channel 18	Channel 19	Channel 1a
	Power in dBm					
Fundamental	15.32	15.01	15.19	6.49	6.52	-5.91
2nd Harmonic	-48.78	-46.22	-44.16	-54.34	-58.2	-80.74
3rd Harmonic	-71.32	-66.11	-68.48	*Note 1*	*Note 1*	*Note 1*
4th Harmonic	-54.61	-59.17	-69.27	*Note 1*	*Note 1*	*Note 1*
5th Harmonic	-63.77	-72.56	-73.15	*Note 1*	*Note 1*	*Note 1*
6th Harmonic	-71.9	-62.94	-66.16	*Note 1*	*Note 1*	*Note 1*
7th Harmonic	-71.87	-70.82	-74.2	*Note 1*	*Note 1*	*Note 1*
8th Harmonic	-68.4	-69.26	-71.11	*Note 1*	*Note 1*	*Note 1*
9th Harmonic	-77.68	-75.16	-70.82	*Note 1*	*Note 1*	*Note 1*
10th Harmonic	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*	*Note 1*

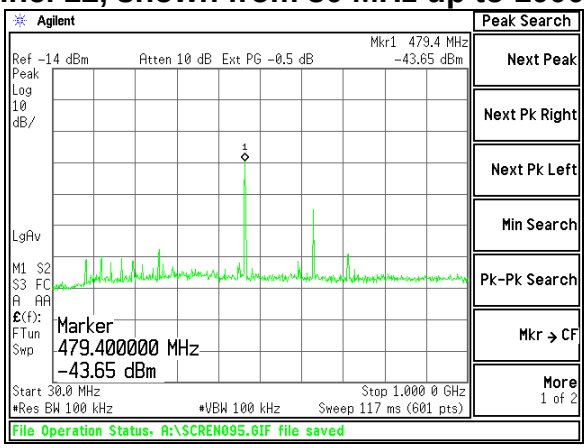
Notes:
(1) Measurement at system noise floor.

11.2 Test Equipment List

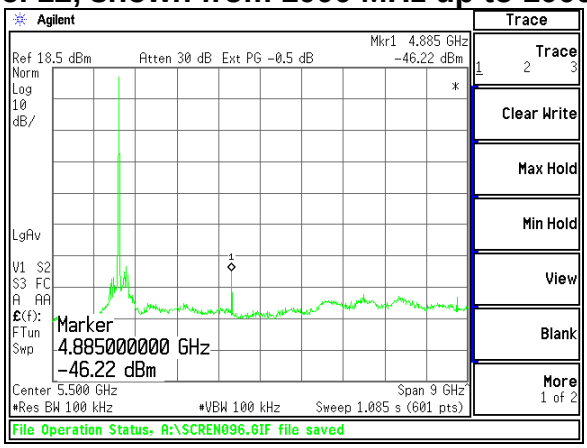
Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

11.3 Screen Captures – Spurious Conducted Emissions

Channel 12, shown from 30 MHz up to 1000 MHz



Channel 12, shown from 1000 MHz up to 10000 MHz



Channel 12, shown from 10000 MHz up to 25000 MHz

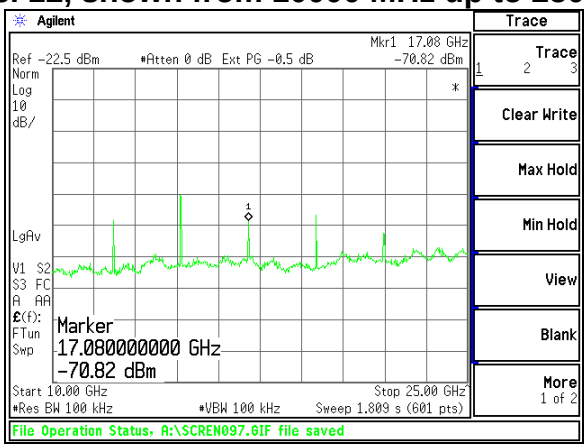


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

The stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers. The transmitter of the EUT placed in modulated continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer.

In this case, the EUT uses a single type operates on a nominal voltage of 3.0 VDC. The test was performed to measure the stability of the frequency and power at ±15% of the nominal operating voltage: 102 VAC and 138 VAC.

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=10Hz settings while the voltage was varied.

	DC/AC Voltage Source		
	102 VAC	120 VAC	138 VAC
Channel b	2404.998200 MHz	2404.998900 MHz	2404.998070 MHz
Channel 12	2440.002250 MHz	2440.002550 MHz	2440.001800 MHz
Channel 17	2464.998580 MHz	2464.998530 MHz	2464.998100 MHz
Channel 18	2470.004080 MHz	2470.002670 MHz	2470.002900 MHz
Channel 19	2475.007700 MHz	2475.006570 MHz	2475.007300 MHz
Channel 1a	2479.999230 MHz	2479.998730 MHz	2479.999600 MHz

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/AC Voltage Source		
	102 VAC	120 VAC	138 VAC
Channel b	19.61 dBm	19.52 dBm	19.58 dBm
Channel 12	19.63 dBm	19.49 dBm	19.62 dBm
Channel 17	19.62 dBm	19.41 dBm	19.56 dBm
Channel 18	12.66 dBm	12.09 dBm	12.54 dBm
Channel 19	10.64 dBm	9.99 dBm	10.61 dBm
Channel 1a	-1.27 dBm	-1.52 dBm	-1.54 dBm

EXHIBIT 13. MPE CALCULATIONS

The following MPE calculations are based on a 2.4 GHz whip antenna, and conducted RF power of +20.03 dBm as presented to the antenna. The manufacturer-declared gain of this antenna, is 2.9 dBi.

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:	20.03	(dBm)
Maximum peak output power at antenna input terminal:	100.693	(mW)
Antenna gain(typical):	2.9	(dBi)
Maximum antenna gain:	1.950	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2400	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)

Power density at prediction frequency:	0.039060	(mW/cm^2)
Maximum allowable antenna gain:	17.0	(dBi)
Margin of Compliance at 20 cm =	14.1	dB

APPENDIX A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	12/6/07	12/6/08
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/19/07	9/19/08
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/19/07	9/19/08
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/04/07	12/04/08
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	1/11/07	1/11/08
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/20/07	9/20/08
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/20/07	9/20/08
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	8/17/07	8/17/08
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

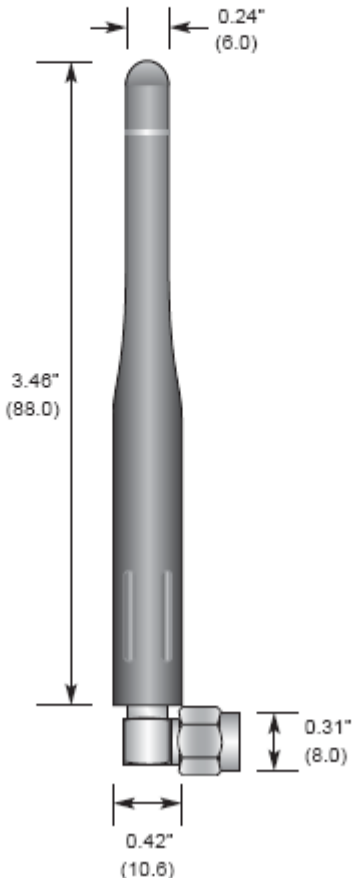
Appendix B

Antenna Specification(s)

ANTENNA FACTOR

ANT-2.4-CW-RCL DATA SHEETS

Product Dimensions



Description

The RCL Series is useful in products where additional height above the product's case is needed or a slightly wider operational bandwidth is desired. The 2.45GHz version has a center-fed 1/2-wave element with an internal ground reference.

Features

- Right-angle mount
- Reduced-height whip
- Excellent performance
- Omni-directional pattern
- Fully weatherized
- Rugged & damage-resistant
- Part 15 compliant RP-SMA connector

Electrical Specifications

- Center Freq. 2.45GHz
- Bandwidth 120MHz
- Wavelength 1/2-wave
- VSWR <1.7 typ. at center
- Impedance 50 ohms
- Gain 2.90dBi
- Connector RP-SMA

Electrical specifications and plots measured on 4.00" x 4.00" reference ground plane

Ordering Information

- ANT-2.4-CW-RCL