ACCREDITED
TESTING CERT #1255.01
LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
W66 N220 Commerce Court ● Cedarburg, WI 53012 ● USA
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

TEST REPORT #: 313156
LSR Job #: C-1737

Compliance Testing of:
ClimateMinder RF Card V3.0

Test Date(s):
June 26 – August 8, 2013

Prepared For:
Attn: Martin C. Martinez
Rain Bird Corporation
970 W. Sierra Madre Ave
Azusa, CA 91702

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:
Peter Feilen, EMC Engineer

Signature: Date: 8/16/13

Test Report Reviewed by:	**Tested by:**
Shane Rismeyer, EMC Engineer	Peter Feilen, EMC Engineer
Signature: Date: 8/15/13	Signature: Date: 8/13/13

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EXHIBIT 1. INTRODUCTION

1.1 Scope

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1.
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15.
Purpose of Test:	To gain FCC Certification Authorization for Low-Power License-Exempt Transmitters.
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.

1.2 Normative References

Publication	Title
47 CFR, Parts 0-15 (FCC)	Code of Federal Regulations - Telecommunications
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.
CISPR 16-1-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
KDB 558074 D01 DTS Meas Guidance v03	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 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.

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:	Rain Bird Corporation
Address:	9491 Ridgehaven Court, San Diego, CA 92123
Contact Name:	Martin C. Martinez Engineering Manager

2.2 Equipment Under Test (EUT) Information

Product Name:	ClimateMinder RF Card V3.0
Model Number:	NODE-RF V3.0
Serial Number:	13240161, 13240162, 13240163, 13240164

2.3 Associated Antenna Description

Antenna A: Half-Wave Dipole Antenna
The Laird WXE antenna can operate from 2400-2500 MHz. This antenna is a half wave dipole antenna that has 50 ohm nominal impedance and a gain of + 3.0 dBi. The antenna can withstand conditions ranging from -40 to +850 ˚C.

Antenna B: Trace antenna

2.4 EUT's Technical Specifications

Additional Information:

EUT Frequency Range (in MHz)	2405-2475 MHz
Maximum Conducted Output Power (dBm)	16.4 dBm
Minimum Conducted Output Power (dBm)	16.2 dBm
Maximum ERP in Watts	0.0437 W
Minimum ERP in Watts	0.0417 W
Occupied Bandwidth (99% BW)	2.66 MHz
Type of Modulation	OQPSK
Emission Designator	2M66F1D
Transmitter Spurious (worst case) at 3 meters	50.9 dBuV/m @2261 MHz
Receiver Spurious (worst case) at 3 meters	47.0 dBuv/m @4946 MHz
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Transceiver Model # (if applicable)	CC2420
Antenna Information	
Detachable/non-detachable	A: Detachable B: Non-detachable
Type	A: Dipole B: Trace
Gain (in dBi)	A: 3 dBi B: 0 dBi
EUT will be operated under FCC Rule Part(s)	FCC 15.247
Modular Filing	☒ Yes ☐ No
Portable or Mobile?	Mobile

2.5 Product Description

Rain Bird® ClimateMinder™ is a wireless climate monitoring and control system for agriculture. It uses mobile network technology to transmit key data from the field directly to growers' mobile phones, computers and control systems.
Operating in the 2.4 GHz band based on a CC2420 chip, the ClimateMinder can be configured with one of two antennas, a dipole or a trace antenna. The EUT operates on channels 11-25 (2405-2475 MHz).

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 Climate Test Conditions

Temperature:	15-35 ˚C
Humidity:	30-60%
Pressure:	645-795 mmHg

3.2 Applicability & Summary of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (yes/no)
FCC : 15.247(a)(2)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC : 15.247(b) & 1.1310	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
FCC :15.247(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(d)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
FCC : 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.		

3.3 Modifications Incorporated in the EUT for Compliance Purposes

☐ **None** ☒ **Yes (explain below)**

Device will operate with highest channel frequency of 2475 MHz, eliminating the use of channel 26 at 2480 MHz.

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 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, RSS GEN and ANSI C63.4. 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 and final testing was performed using continuous, modulated transmit mode. The unit has the capability to operate on 15 channels.

The applicable limits 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 (2475 MHz) to comply with FCC Part 15.31(m). The channels and operating modes were changed using a PC.

5.2 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 25000 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. From 18 GHz to 25 GHz, the EUT was measured using a standard gain Horn Antenna and pre-amplifier.

The EUT was rotated along three orthogonal axes during the investigations 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 an EMI System. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz for peak measurements, 10Hz for average measurements). From 4 GHz to 18 GHz, an Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the Spectrum Analyzer as well as a standard gain horn, and preamp were used.

Test Equipment List

Please see Appendix A

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. 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) and RSS 210 A8.4 is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d) and RSS 210 A8.2(b), 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) for FCC.

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	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
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 9.5 = 63.5 dB/μV/m at 1 meter

Sample Calculation using correction factors from the device

Raw Receiver Data + Antenna Factor + Cable Factor + = Reported Value

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 dBμV

5.6 Radiated Emissions Test Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions
Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	Rain Bird Corporation					
Date(s) of Test:	June 26-July 11, 2013					
Test Engineer(s):	Peter Feilen, Mike Hintzke					
Operation Mode:	Continuous, modulated transmit mode					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
	X	3.3 VDC Bench Supply		Other:		
EUT Placement:	X	80cm non-conductive table		10cm Spacers		
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS		
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:	X	Peak	X	Quasi-Peak	X	Average

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Average Field Strength Reading (dBµV/m)	Average Field Strength Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2261.1	1.05	70	50.3	54.0	3.7	Horizontal	Flat
1965.3	1.25	71	46.9	54.0	7.2	Horizontal	Flat
2261.0	1.19	125	49.6	54.0	4.5	Vertical	Vertical
1965.2	1.00	336	47.1	54.0	6.9	Horizontal	Vertical
2261.0	1.07	340	50.9	54.0	3.2	Horizontal	Vertical
2261.2	1.24	146	45.6	54.0	8.4	Vertical	Vertical

RADIATED EMISSIONS DATA CHART *(continued)*

Trace Antenna

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 11:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
12025	1.00	322	64.9	54.5	63.5	9.0	Horizontal	Vertical
19240	1.00	126	52.0	40.5	63.5	23.0	Vertical	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 18:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1.04	68	58.4	49.1	63.5	14.4	Vertical	Flat
7320	1.09	227	71.1	60.1	63.5	3.4	Horizontal	Side
12200	1.00	227	68.0	57.0	63.5	6.5	Horizontal	Vertical
19520	Note 3							

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 25:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4950	1.00	200	59.1	49.6	63.5	13.9	Vertical	Flat
7425	1.13	226	69.1	58.1	63.5	5.4	Horizontal	Side
12375	1.00	227	68.9	58.0	63.5	5.5	Horizontal	Vertical
19800	Note 3							
22275	Note 2							

Dipole Antenna

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 11:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4810	1.1	227	57.9	48.6	63.5	14.9	Horizontal	Flat
12025	1.02	121	64.5	54.0	63.5	9.5	Horizontal	Side
19240	Note 3							

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 18:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1	259	60.1	51.3	63.5	12.2	Horizontal	Flat
7320	1	259	66.9	55.7	63.5	7.8	Horizontal	Side
12200	1.05	119	70.9	59.6	63.5	3.9	Horizontal	Side
19520	Note 3							

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 25:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1.00	214	53.4	43.9	63.5	19.6	Vertical	Vertical
7440	1.00	132	68.6	57.2	63.5	6.3	Horizontal	Flat
12400	1.00	127	70.0	59.2	63.5	4.3	Horizontal	Side
19840	Note 3							
22320	Note 2							

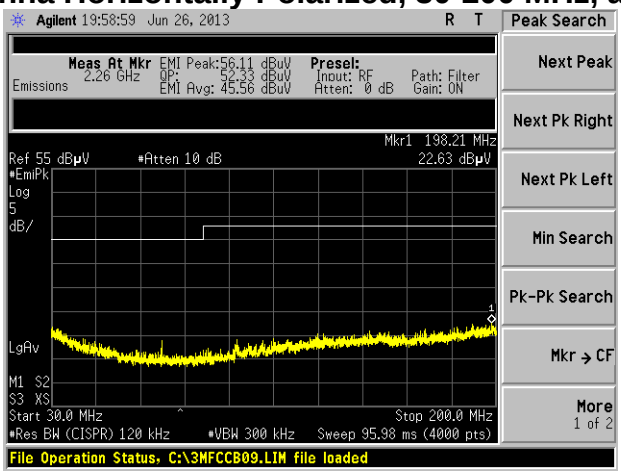
Notes:
1) A peak as well as an average detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements at system noise floor
3) Measurement demonstrates 20 dB of margin or greater

5.7 Screen Captures - Radiated Emissions Test

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.

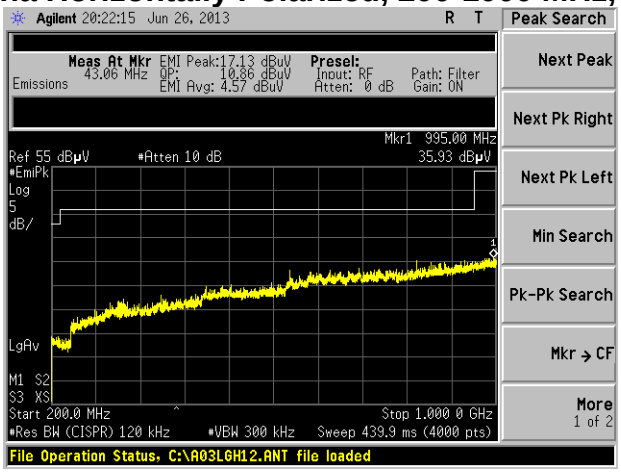
The signature scans shown here are from worst-case emissions, as measured on channels 11, 18 or 25, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Antenna Horizontally Polarized, 30-200 MHz, at 3m



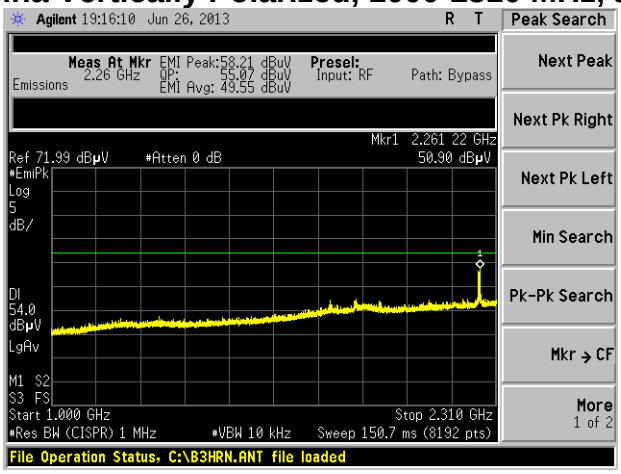
Note: 72 MHz spur is ambient noise, not related to the EUT

Antenna Horizontally Polarized, 200-1000 MHz, at 3m



Screen Captures - Radiated Emissions Testing *(continued)*

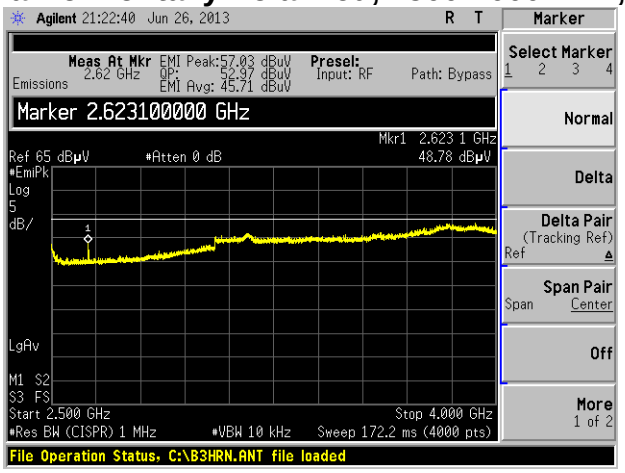
Antenna Vertically Polarized, 1000-2310 MHz, at 3m



2310-2390 MHz is represented in Section 8, Bandedge Measurements

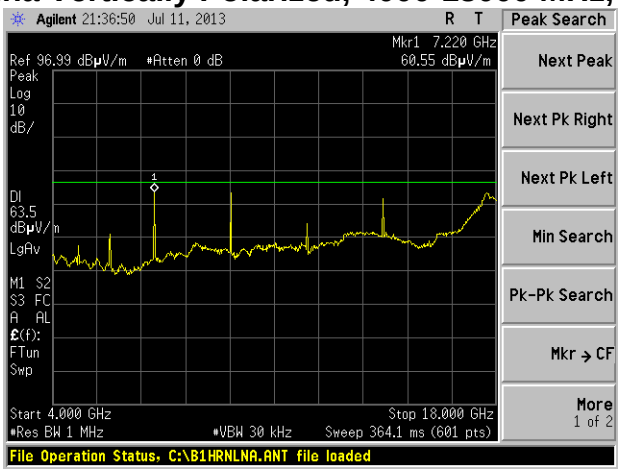
2483.5-2500 MHz is represented in Section 8, Bandedge Measurements

Antenna Horizontally Polarized, 2500-4000 MHz, at 3m

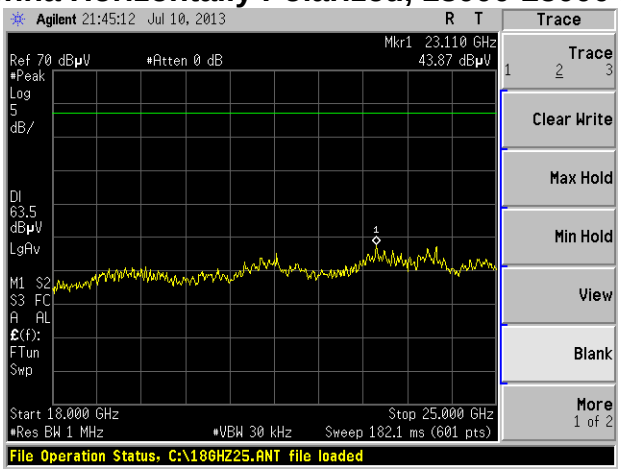


Screen Captures - Radiated Emissions Testing *(continued)*

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



Antenna Horizontally Polarized, 18000-25000 MHz



5.9 Receive Mode Testing

The test setup, procedure, and equipment utilized were identical to that described in sections 5.1, 5.2, and 5.3 of this document.

Measurement data and screen captures from the receive tests are presented below:

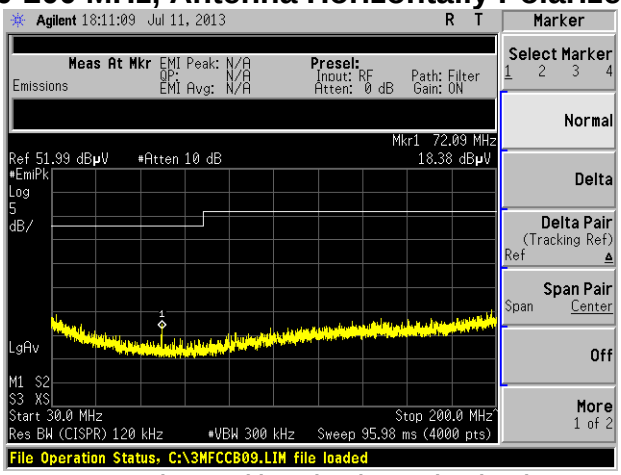
Frequency (MHz)	Height (m)	Azimuth (degree)	Field Strength Reading (dBµV/m)	Field Strength Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4786.1	1.20	156	46.0	63.5	17.5	Horizontal	Vertical
4806.1	1.20	140	40.8	63.5	22.7	Horizontal	Side
4946.1	1.00	196	47.0	63.5	16.5	Vertical	Side

Screen Captures - Radiated Emissions Testing – Receive Mode

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.

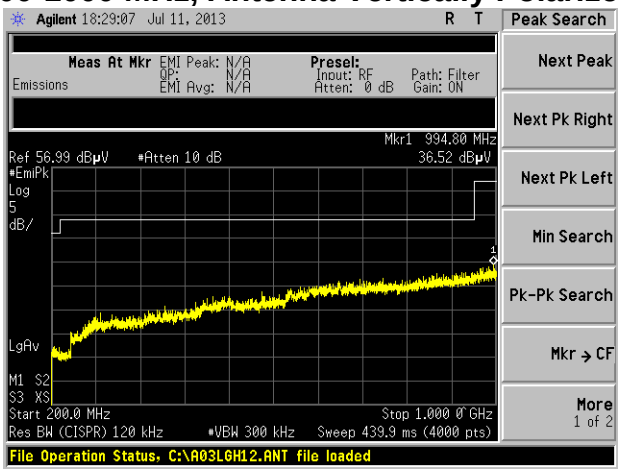
The signature scans shown here are from worst-case emissions, as measured on channels 11, 18 or 25, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

30-200 MHz, Antenna Horizontally Polarized



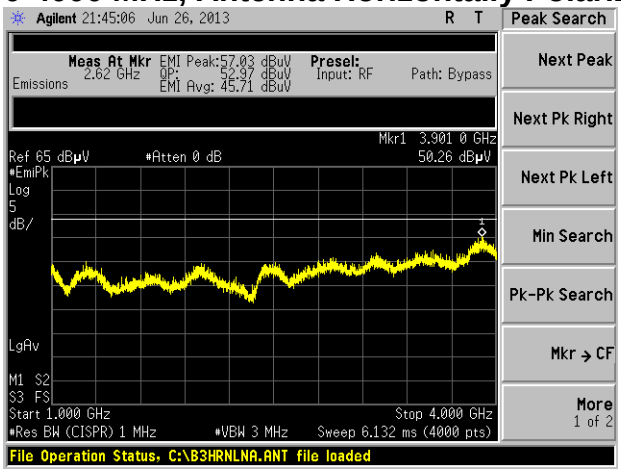
Note: 72 MHz is an ambient signal, not related to the EUT

200-1000 MHz, Antenna Vertically Polarized

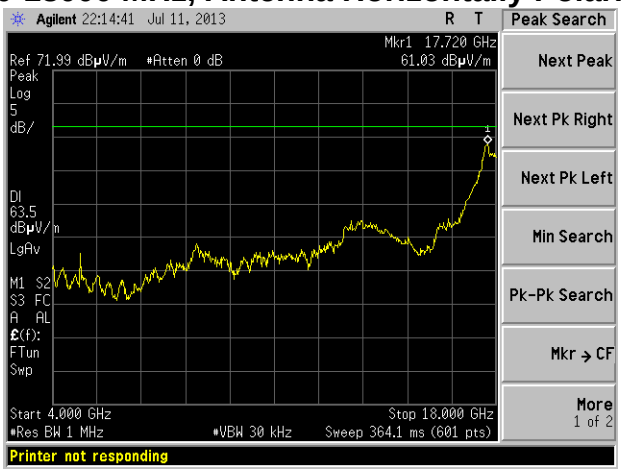


Screen Captures - Radiated Emissions Testing – Receive Mode **(continued)**

1000-4000 MHz, Antenna Horizontally Polarized



4000-18000 MHz, Antenna Horizontally Polarized



18000-25000 MHz, Antenna Horizontally Polarized

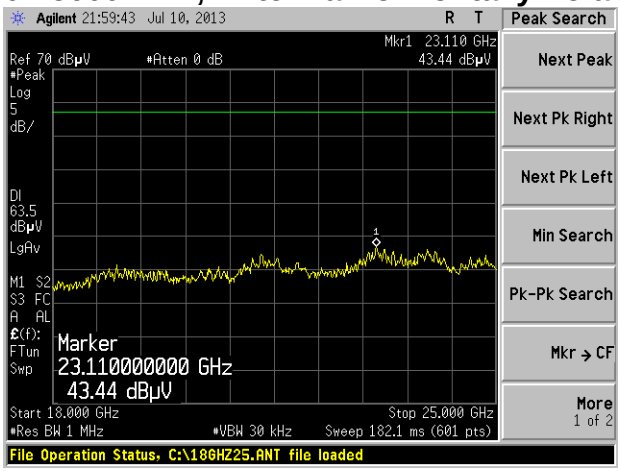


EXHIBIT 6. OCCUPIED BANDWIDTH:

6.1 Limits

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

6.2 Method of Measurements

Refer to ANSI C63.4 and KDB 558074 D01 DTS Meas Guidance v03 (04-2013) 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 6 dBc 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 Agilent E4446A spectrum analyzer. An Agilent model E4446A 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, modulated transmit mode. 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 (6 dB bandwidth) when compared to the specified limit, is 1630 kHz, which is above the minimum of 500 kHz.

6.3 Test Equipment List

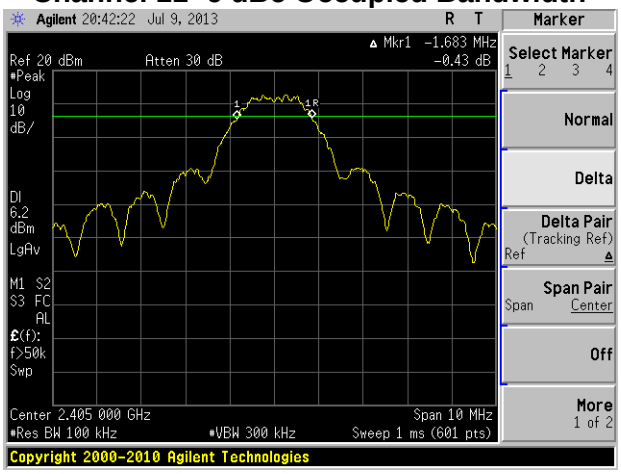
Please see Appendix A

6.4 Test Data

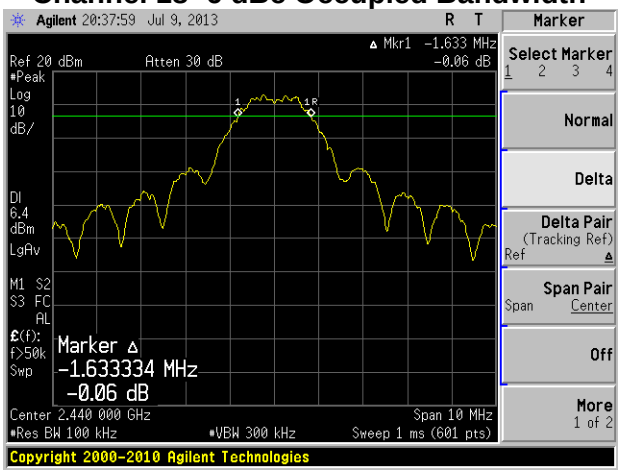
Channel	20dB (MHz)	99% (MHz)	6 dB (MHz)
11	2.64	2.28	1.68
18	2.62	2.27	1.63
25	2.29	2.66	1.78

6.5 Screen Captures - OCCUPIED BANDWIDTH

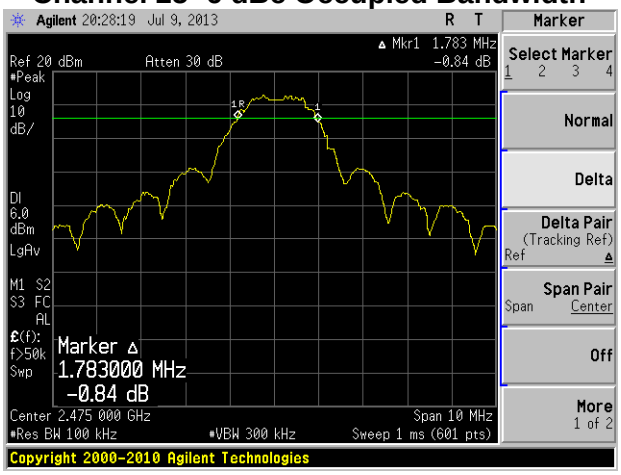
Channel 11 -6 dBc Occupied Bandwidth



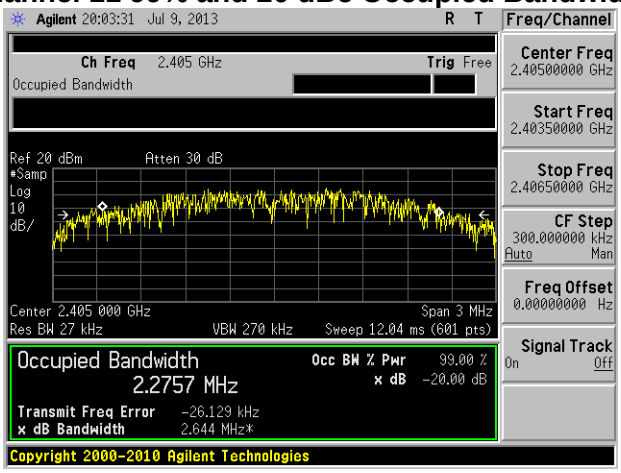
Channel 18 -6 dBc Occupied Bandwidth



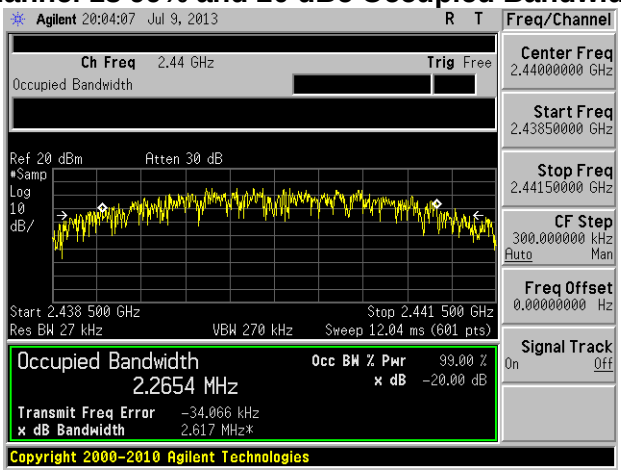
Channel 25 -6 dBc Occupied Bandwidth



Channel 11 99% and 20 dBc Occupied Bandwidth



Channel 18 99% and 20 dBc Occupied Bandwidth



Channel 25 99% and 20 dBc Occupied Bandwidth

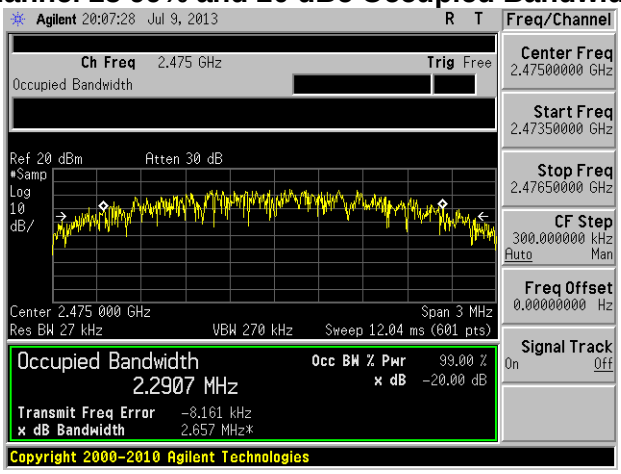


EXHIBIT 7. BAND-EDGE MEASUREMENTS

7.1 Test Description

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.

7.2 Method of Measurements

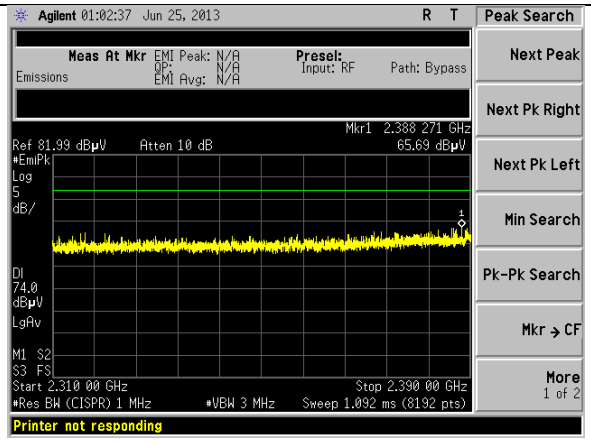
The following screen captures demonstrate compliance in the 15.205 restricted bands at the band-edges of the intentional radiator at the 2400-2483.5 MHz band-edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The 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.

For a 2.4 GHz Transmitter:

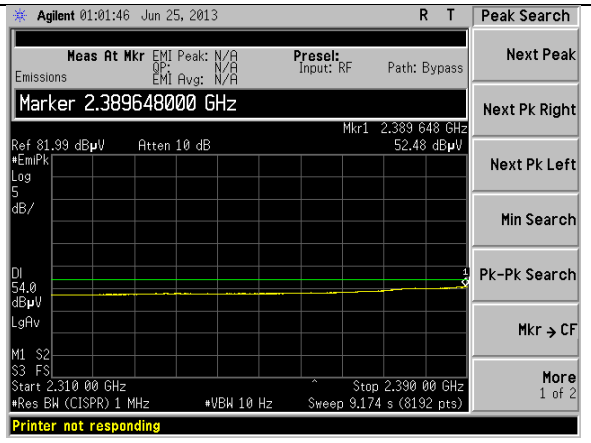
The Lower Band-Edge limit, in this case, would be + 54 dBµV/m at 3m.

The Upper Band-Edge limit, in this case, would be + 54 dBµV/m at 3m.

Screen Capture Demonstrating Compliance at the Lower Band-Edge with Trace Antenna

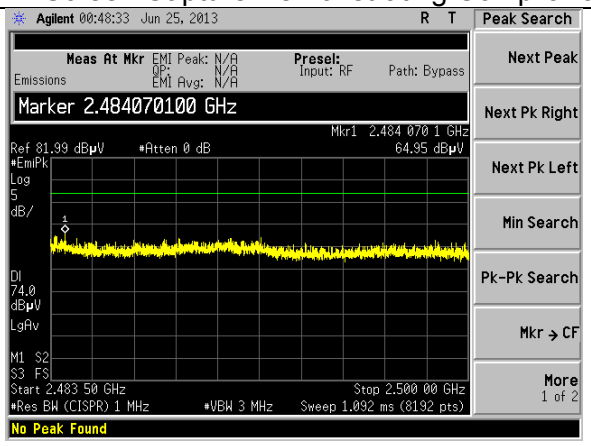


Peak

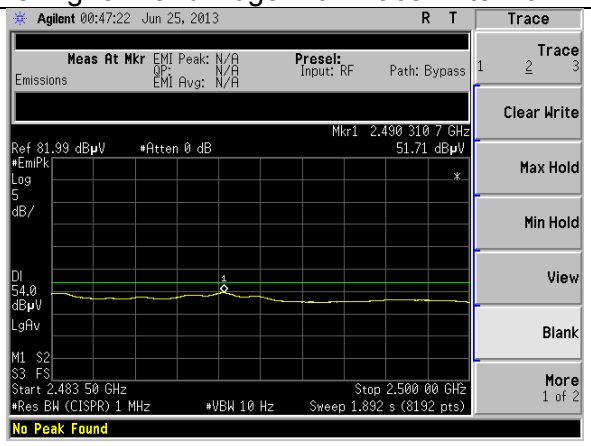


Average

Screen Capture Demonstrating Compliance at the Higher Band-Edge with Trace Antenna

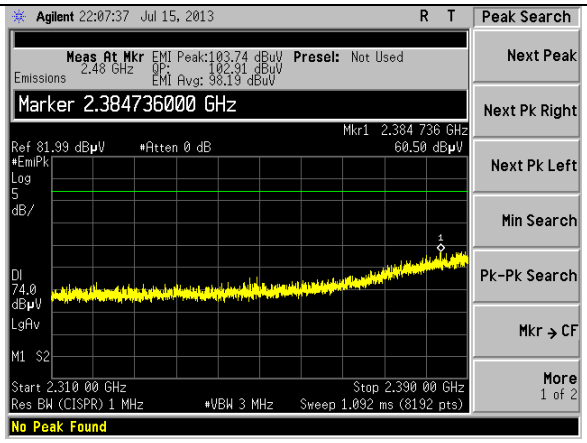


Peak

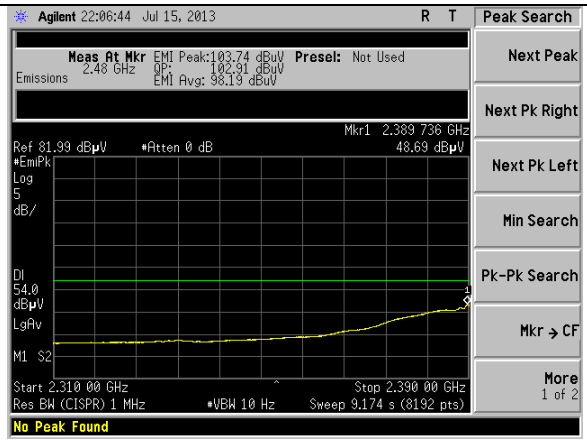


Average

Screen Capture Demonstrating Compliance at the Lower Band-Edge with Dipole Antenna

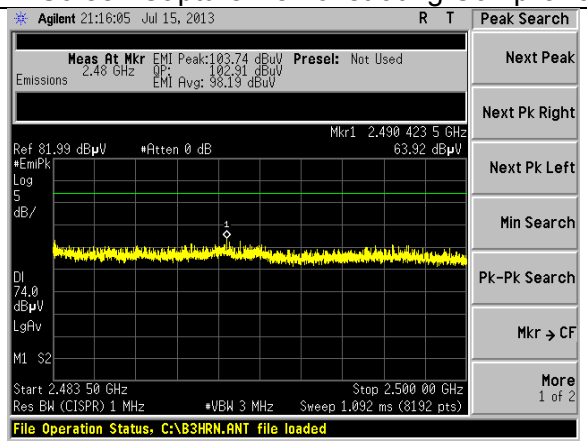


Peak

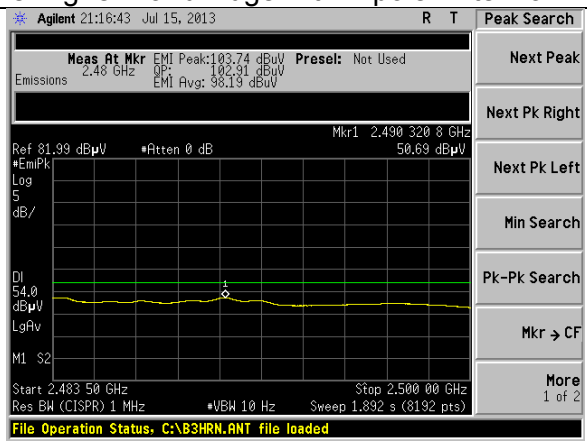


Average

Screen Capture Demonstrating Compliance at the Higher Band-Edge with Dipole Antenna



Peak



Average

EXHIBIT 8. POWER OUTPUT (CONDUCTED): 15.247(b)

8.1 Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port with a direct connection to the spectrum analyzer thereby allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous modulated transmit mode. Measurements from a peak detector presented in the chart below.

8.2 Test Equipment List

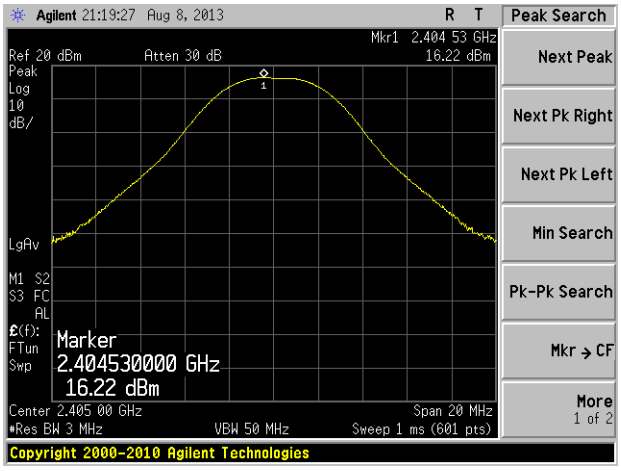
Please see Appendix A

8.3 Test Data

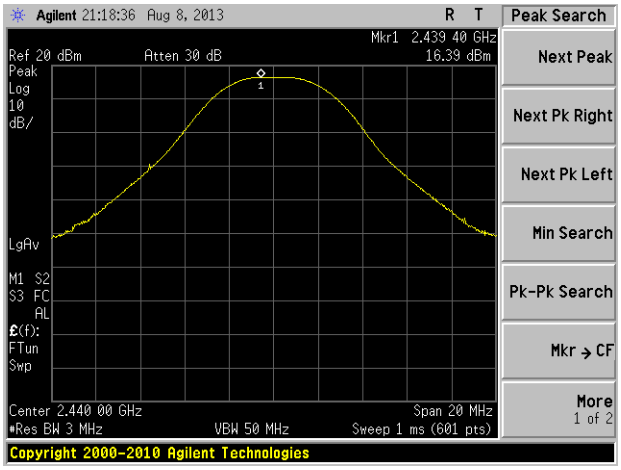
Channel	Power (dBm)	Limit	Margin (dB)
11	16.2	30.0	13.8
18	16.4	30.0	13.6
25	16.4	30.0	13.6

8.4 Screen Captures – Power Output (Conducted)

Channel 11



Channel 18



Channel 25

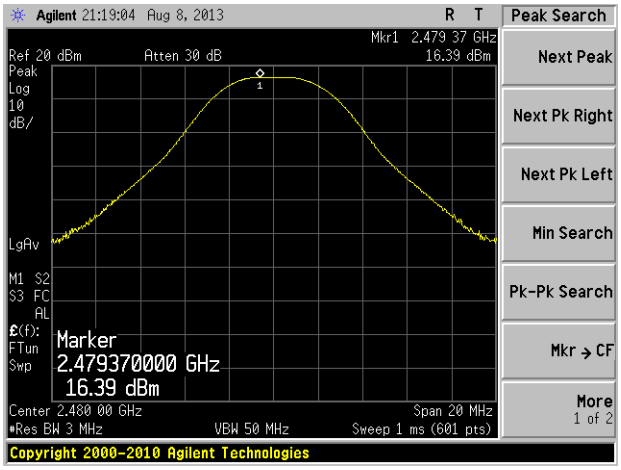


EXHIBIT 9 POWER SPECTRAL DENSITY: 15.247(e)

9.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator at 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 with a 3 kHz bandwidth. The highest density was found to be no greater than 2.3 dBm, which is under the allowable limit by 5.7 dB.

9.2 Test Equipment List

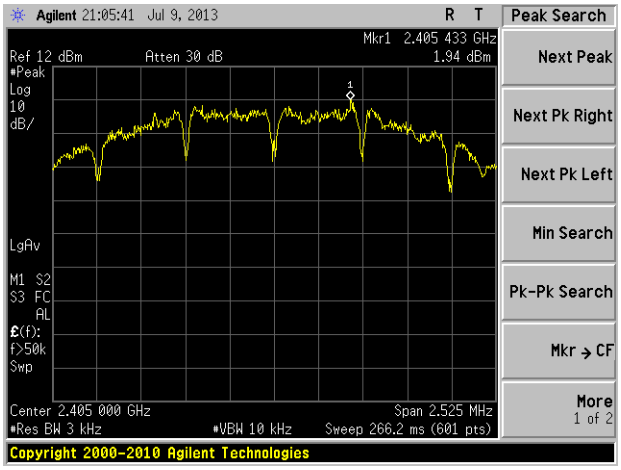
Please see Appendix A

9.3 Test Data

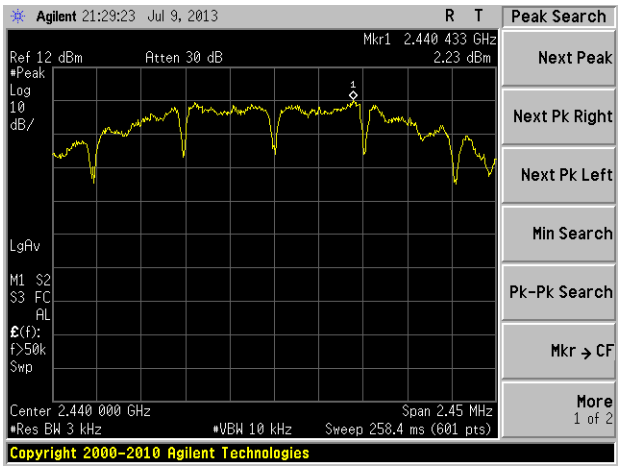
Channel	PSD/3kHz (dBm)	Limit (dBm)	Margin (dB)
11	1.9	8.0	6.1
18	2.2	8.0	5.8
25	2.3	8.0	5.7

9.4 Screen Captures – Power Spectral Density

Channel 11



Channel 18



Channel 25

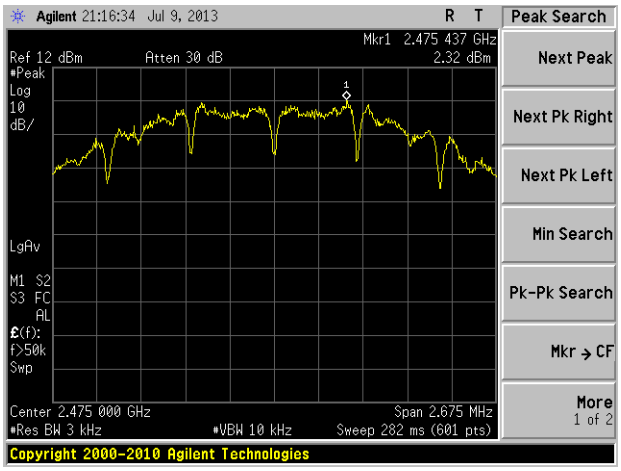


EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

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 least 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)

FCC Part 15.247(d) require 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 direct connection to the spectrum analyzer there by allowing direct readings of the measurements made without the need for any further corrections. An Agilent 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, 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

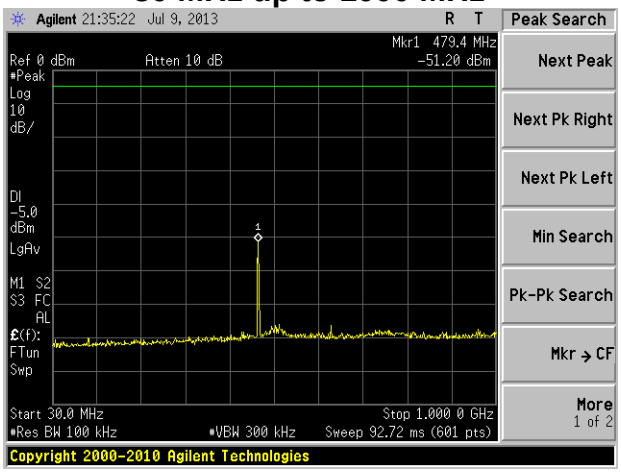
Please see Appendix A

11.3 Test Data

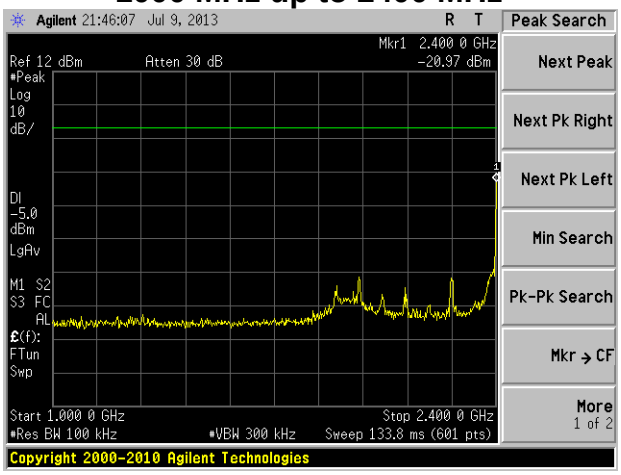
Frequency	Channel 11 2405 MHz	Channel 18 2440 MHz	Channel 25 2475 MHz
fo	15.6	15.8	15.8
2fo	-60.1	-63.3	-64.3
3fo	-61.3	-61.5	-62.8
4fo	-47.3	-46.2	-42.1
5fo	-46.8	-45.6	-45.6
6fo	-43.4	-44.3	-45.1
7fo	-63.7	-65.2	-66.4
8fo	-76.2	-74.4	-74.4
9fo	-75.5	-75.4	-75.8
10fo	-69.3	-74.2	-71.3

11.4 Screen Captures – Spurious Conducted Emissions

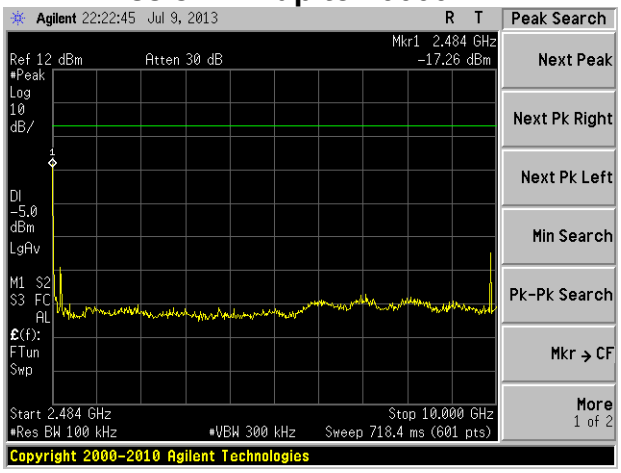
30 MHz up to 1000 MHz



1000 MHz up to 2400 MHz



2483.5 MHz up to 10000 MHz



10000 MHz up to 25000 MHz

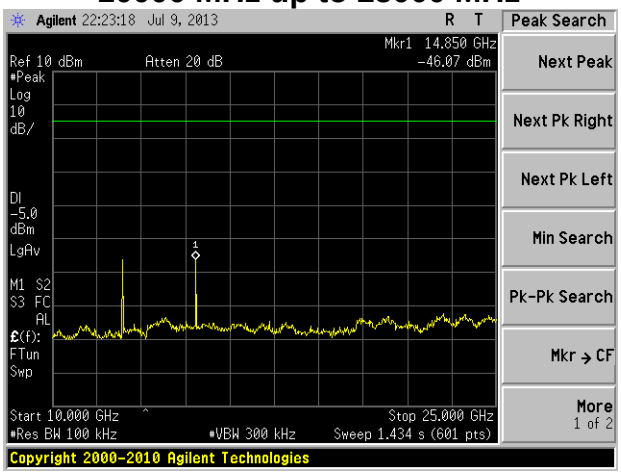


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

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. 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 operates at 3.3 VDC nominal voltage, with a +/- 15% tolerance allowable.

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=1 kHz settings while the voltage was varied. The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=3 MHz setting while the voltage was varied.

Channel	2.8 VDC		3.3 VDC		3.8 VDC	
	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)
11	16.0	2405433000	16.1	2405433000	16.1	2405467000
18	16.0	2440443000	16.1	2440417000	16.1	2440450000
25	15.9	2475433000	16.1	2475433000	16.0	2475433000

Channel	Maximum Frequency Drift (Hz)
11	24000
18	33000
25	0

$$Example\ At\ 2440\ MHz\ fundamental\ frequency$$

$100\ ppm$: $\frac{100}{1000000}\ X\ 2{,}400{,}000{,}000$ = ~240 kHz ≤240000 Hz of drift to meet 100 ppm requirement

F_H-F_L =F_{Delta}

$$\frac{\text{FDelta}}{2{,}400{,}000{,}000} = 'X'\ ppm$$

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.

APPENDIX A
Instrumentation Sheet

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 19-Jun-2013 Type Test : Radiated Emissions Job # : C-1737

Prepared By: Pete/Mike Customer : RainBird Quote #: 313156

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/28/2013	5/28/2014	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/12/2013	6/12/2014	Active Calibration
3	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/29/2013	1/29/2014	Active Calibration
4	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	2/1/2013	2/1/2014	Active Calibration
5	AA 960154	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-02	7/19/2013	7/19/2014	Active Calibration
6	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	2/11/2013	2/11/2014	Active Calibration
7	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	2/11/2013	2/11/2014	Active Calibration
8	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	12/12/2012	12/12/2013	Active Calibration
9	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	12/10/2012	12/10/2013	Active Calibration
10	AA 960158	Double Ridge Horn Antenna	EMCO	3117	109300	3/28/2013	3/28/2014	Active Calibration
11	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	740411007	3/28/2013	3/28/2014	Active Calibration
12	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	69259	10/4/2011	10/4/2014	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 19-Jun-2013 Type Test : Conducted Radio Measurements Job # : C-1737

Prepared By: Peter Customer : RainBird Quote #: 313156

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/12/2013	6/12/2014	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/28/2013	5/28/2014	Active Calibration

APPENDIX B – TEST STANDARDS: CURRENT PUBLICATION DATES

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2009	2009-12 P	
FCC Public Notice DA 00-1407	2000		
FCC Procedures	2013		

APPENDIX C
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*	*4.82 dB*
Radiated Emissions	*3-Meter Chamber, Log Periodic Antenna*	*4.88 dB*
Radiated Emissions	*3-Meter Chamber, Horn Antenna*	*4.85 dB*
Radiated Emissions	*10-Meter OATS, Biconical Antenna*	*4.32 dB*
Radiated Emissions	*10-Meter OATS, Log Periodic Antenna*	*3.63 dB*
Absolute Conducted Emissions	*Agilent PSA/ESA Series*	*1.38 dB*
AC Line Conducted Emissions	*Shielded Room/EMCO LISN*	*3.20 dB*
Radiated Immunity	*3 Volts/Meter in 3-Meter Chamber*	*2.05 Volts/Meter*
Conducted Immunity	*3 Volts level*	*2.33 V*
EFT Burst, Surge, VDI	*230 VAC*	*54.4 V*
ESD Immunity	*Discharge at 15kV*	*3200 V*
Temperature/Humidity	*Thermo-hygrometer*	*0.64° / 2.88 %RH*