LS RESEARCH LLC
Wireless Product Development

ACCREDITED
TESTING CERT #1255.01

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TEST REPORT # 313049-A
LSR Job #: C-1677

Compliance Testing of:
Whistle Dog Monitor

Test Date(s):
July 19-31, August 1-14, 2013

Prepared For:
Whistle
251 Rhode Island St
Suite 211
San Francisco, CA 94103

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Industry Canada (IC) RSS 210 Annex 8
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz

This Test Report is issued under the Authority of:

Signature: Date:

Test Report Reviewed by:	**Tested by:**
Ryan M. Urness, Quality & Operations Manager	Peter Feilen, EMC Engineer
Signature: Date: 8-27-13	Signature: Date: 8-21-13

Contents

EXHIBIT 1. INTRODUCTION

1.1 Scope

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 RSS GEN and RSS 210 Annex 8
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC 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
RSS 210 Annex 8	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
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.
ANSI C63.10	American National Standard for Testing Unlicensed Wireless Devices
KDB 558074 D01 DTS Meas Guidance v03r01	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 the requirements of 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. Accreditation status can be verified at A2LA’s web site: A2LA.org

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.

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 by a calibration laboratory accredited to the requirements of ISO 17025 and are traceable to the SI standard.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 Client Information

Manufacturer Name:	Whistle Labs Inc
Address:	251 Rhode Island St, San Francisco, CA 94103
Contact Name:	Kevin Lloyd

2.2 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	Whistle Dog Monitor
Model Number:	W01A
Serial Number:	Engineering Sample

2.3 Associated Antenna Description

A modified PIFA antenna is used in this EUT.

The antenna tuning is dependent on the EUT housing structure and material.

2.4 EUT's Technical Specifications

EUT Frequency Range (in MHz)	WLAN: 2412-2462 MHz Bluetooth Low Energy: 2402-2480 MHz
Minimum EIRP in Watts	11b: 0.0345 11g: 0.0537 11n: 0.0324 Bluetooth Low Energy: 0.0016
Maximum EIRP in Watts	11b: 0.1000 11g: 0.2090 11n: 0.0427 Bluetooth Low Energy: 0.0020
Minimum Conducted Output Power (in dBm)	11b: 15.4 dBm 11g: 17.3 dBm 11n: 15.1 dBm Bluetooth Low Energy: 2.0 dBm
Maximum Conducted Output Power (in dBm)	11b: 20.0 dBm 11g: 23.2 dBm 11n: 16.3 dBm Bluetooth Low Energy: 3.0 dBm
Occupied Bandwidth (99% BW) (MHz)	11b: 13.99 MHz 11g: 16.75 MHz 11n: 17.61 MHz Bluetooth Low Energy: 1.06 MHz
Type of Modulation	11b: QPSK 11g: BPSK 11n: 64-QAM Bluetooth Low Energy: DQPSK
Emission Designator	11b: 14M0D2W 11g: 16M7D2W 11n: 17M6D2W Bluetooth Low Energy: 1M06FXD
Transmitter Spurious (worst case) at 3 meters	41.49 dBuV/m @ 3m
Receiver Spurious (worst case) at 3 meters	42.92 dBuV/m @ 3m
Receiver Sensitivity	-92 dBm
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Transceiver Model # (if applicable)	Atheros 4100P SIP
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Modified PIFA
Gain (in dBi)	0 dBi
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	RSS 210
Modular Filing	☐ Yes ☒ No
Portable or Mobile?	Portable

RF Technical Information:

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

2.5 Product Description

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Whistle is a consumer electronics product for dogs that measures activity levels and transmits them to company servers via Bluetooth and/or WiFi connections.

Whistle is powered via a 200mAH lithium-polymer battery, through a TI TPS62402 dual-voltage (1.8V and 3.3V) switching power supply (switching frequency: 2.2MHz).

Whistle uses an Atheros AR4100P 802.11b/g/n SIP (system-in-package), which has a dedicated piece of 2Mbit SPI NOR flash. It operates in the 2.4GHz band. The SIP contains a 26MHZ crystal oscillator and all necessary transceiver power supplies and amplifiers. It also has an integrated RF front-end (with direct connection to a 50-ohm antenna), RF shield, and 32kHz sleep clock. It is connected to the MCU via a SPI interface.

The device was programmed through a PC, with USB interface and utilizing TeraTerm and UART software for programming, using commands issued by the device manufacturer specific to the Atheros chip.

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) IC : RSS 210 A8.2(a)	6 dB Bandwidth of a Digital Modulation System	Yes
IC : RSS GEN section 4.6.1	99% Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(d) IC : RSS 210 A8.2(b),	Power Spectral Density	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(c) IC : RSS 210 A8.2(b)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(d), 15.209 & 15.205 IC : RSS 210 A8.5, section 2.2, 2.5	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 (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). 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, Issue 8 (2010), 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 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 transmit mode. The unit has the capability to operate on 11 channels, controllable via laptop PC.

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 (2412 MHz), middle (2437 MHz) and high (2462 MHz) to comply with FCC Part 15.31(m).

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 by a calibration laboratory accredited to the requirements of ISO 17025 and are traceable to the SI Standard. 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, a Spectrum Analyzer and an 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 and Canada RSS-210, Issue 8 (2010), Annex 8 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 and section 2.2,2.6 and 2.7 of RSS 210 for IC.

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. The mentioned limits correspond to those limits listed in RSS 210 section 2.7.

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:	Whistle						
Date(s) of Test:	July 19-25, August 1-2, 2013						
Test Engineer(s):	Peter Feilen, Mike Hintzke						
Operation Mode:	Continuous transmit mode						
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %						
EUT Power:		Single Phase ___VAC			3 Phase ___VAC		
	X	Battery			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)	Peak Reading (dBµV/m)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
87.6	1.00	0	37.42	31.82	40.0	8.2	Vert	Vert
87.6	1.00	0	34.08	20.54	40.0	19.5	Vert	Side
858.0	1.17	229	42.3	40.68	46.0	5.3	Vert	Vert
702.0	1.00	216	41.01	38.95	46.0	7.1	Vert	Vert
572.0	1.00	0	38.3	36.71	46.0	9.3	Vert	Vert
416.0	1.00	0	33.51	31.51	46.0	14.5	Vert	Vert
312.0	1.29	37	33.16	31.13	46.0	14.9	Vert	Vert
858.0	1.24	0	42.84	41.49	46.0	4.5	Vert	Flat
624.0	1.00	321	39.17	37.57	46.0	8.4	Vert	Flat
702.0	1.00	204	40.84	39.03	46.0	7.0	Vert	Flat
572.0	1.00	0	35.95	33.92	46.0	12.1	Vert	Flat

RADIATED EMISSIONS DATA CHART *(continued)*

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

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4824	1.03	19	52.2	46.4	63.5	17.1	Vertical	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 6:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4874	1.04	6	52.0	47.0	63.5	16.5	Vertical	Flat

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
4924	1.09	184	52.1	46.3	63.5	17.2	Horizontal	Side

Notes:

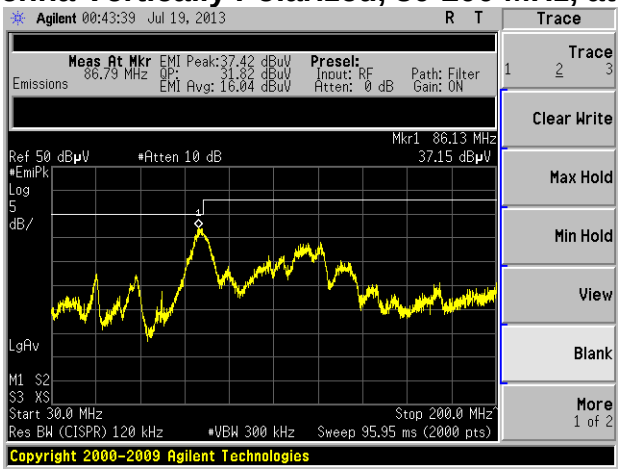
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the average limits.
2) Measurements above 4 GHz were made at 1 meters of separation from the EUT

5.7 Screen Captures - Radiated Emissions Test

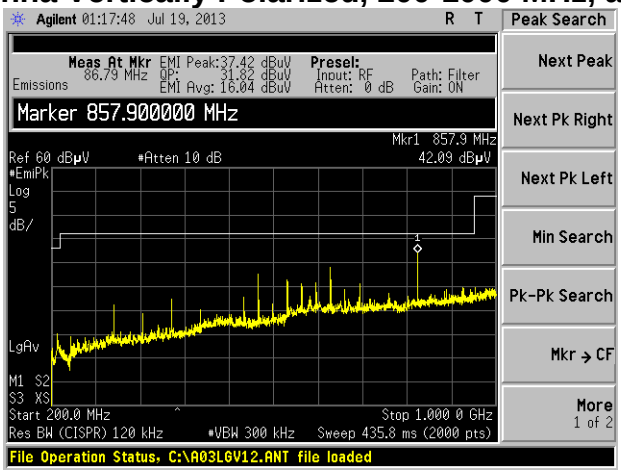
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, determined with the sense antenna both in vertical and horizontal polarity for worst case presentations.

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

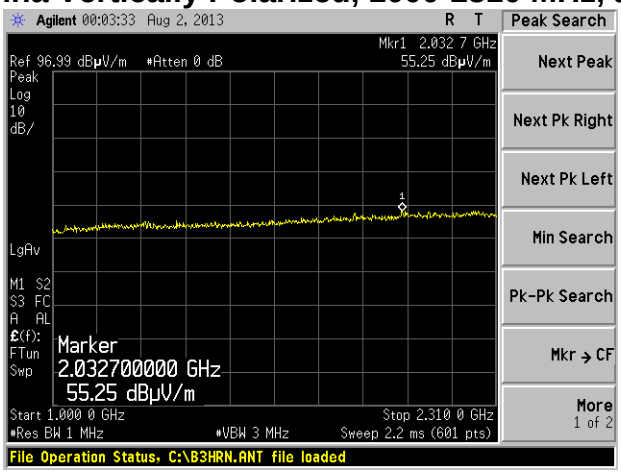


Antenna Vertically Polarized, 200-1000 MHz, at 3m

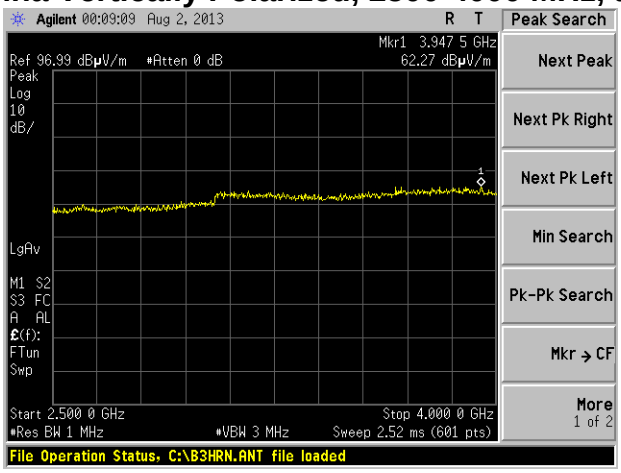


Screen Captures - Radiated Emissions Testing *(continued)*

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



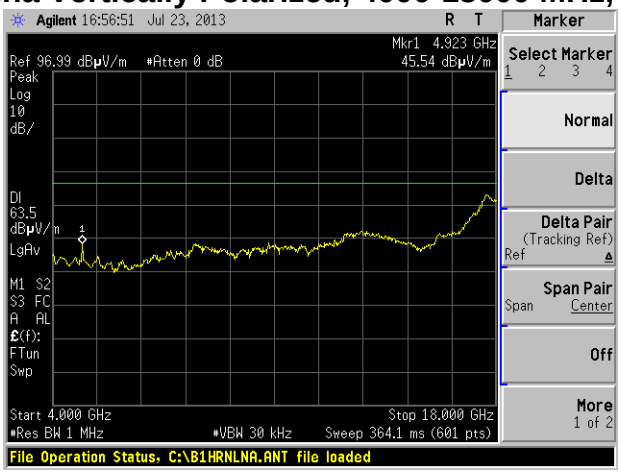
Antenna Vertically Polarized, 2500-4000 MHz, at 3m



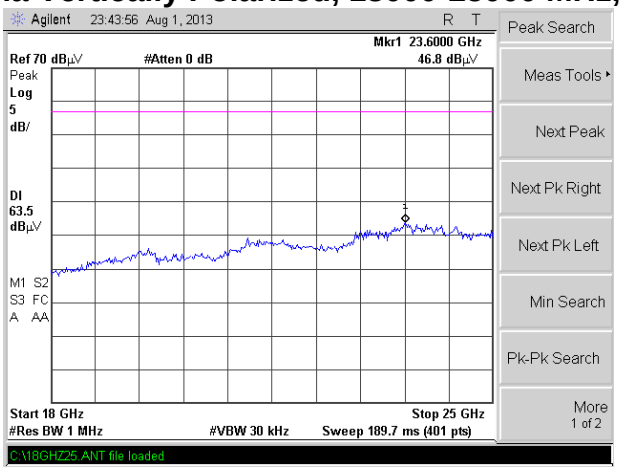
2310-2390 MHz and 2483.5-2500 MHz ranges are represented in Section 8, Bandedge Measurements

Screen Captures - Radiated Emissions Testing *(continued)*

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



Antenna Vertically Polarized, 18000-25000 MHz, at 1m



5.9 Receive Mode Testing

Per the requirements of RSS-210, the EUT was placed in continuous receive mode and the radiated spurious emissions were measured and compared to the limits stated in RSS-Gen Section 4.10.

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:

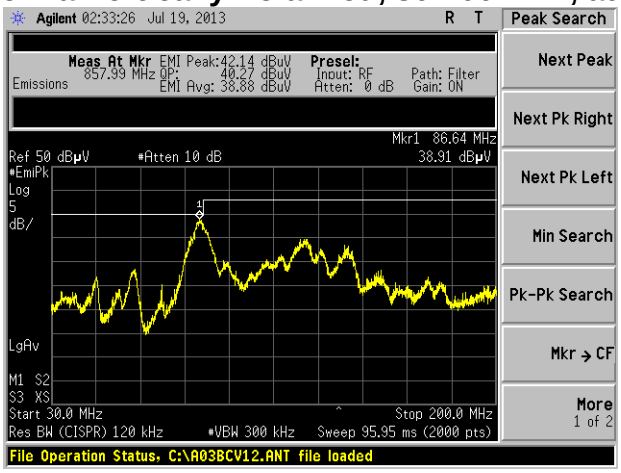
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
572.0	1.00	0	36.66	34.65	46.0	11.4	Vert	Flat
858.0	1.22	350	42.62	41.27	46.0	4.7	Vert	Flat
858.0	1.24	333	43.96	42.92	46.0	3.1	Vert	Vert
858.0	1.00	342	37.26	34.28	46.0	11.7	Horiz	Vert
858.0	1.02	270	42.14	40.27	46.0	5.7	Horiz	Flat
86.6	1.00	0	38.32	32.36	40.0	7.6	Vert	Vert

Screen Captures - Radiated Emissions Testing – Receive Mode

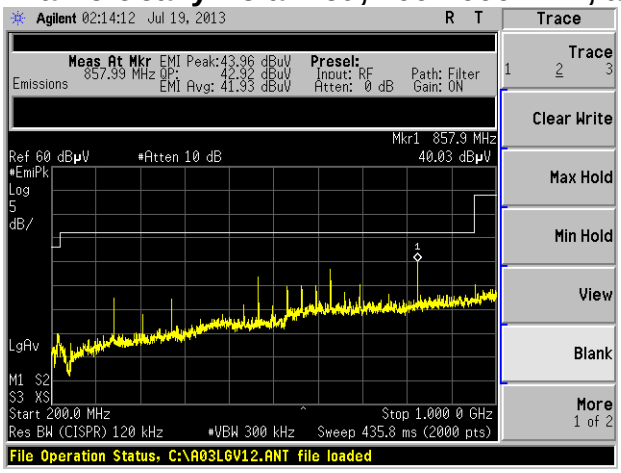
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 1, 6 and 11, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

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

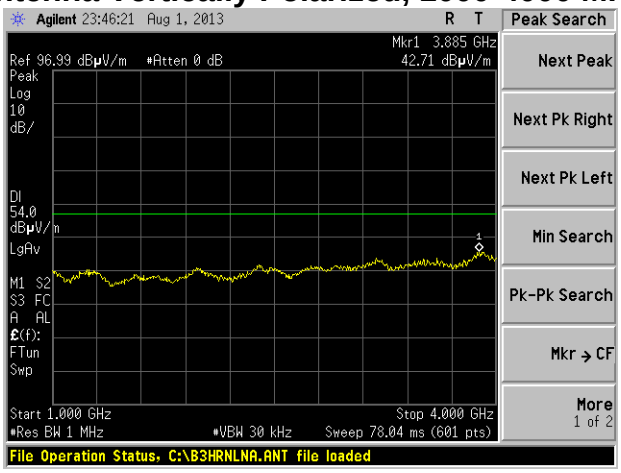


Antenna Vertically Polarized, 200-1000 MHz, at 3m



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

Antenna Vertically Polarized, 1000-4000 MHz



Antenna Vertically Polarized, 4000-18000 MHz

Antenna Vertically Polarized, 18000-25000 MHz

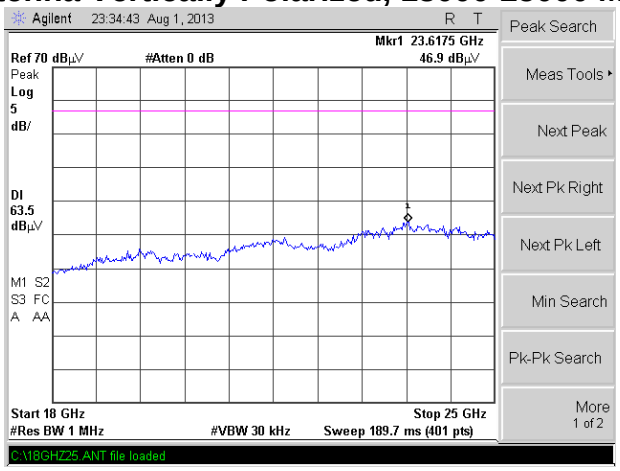


EXHIBIT 6. OCCUPIED BANDWIDTH:

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 v03r01 (04-2013) for Digital Transmission Systems operating under 15.247.

The bandwidth requirement found in FCC Part 15.247(a)(2) and RSS 210 A8.2(a) requires a minimum 6 dBc occupied bandwidth of 500 kHz. In addition, Industry Canada (IC RSS GEN 4.6.1) requires the measurement of the 99% occupied bandwidth. 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 spectrum analyzer. A spectrum analyzer was used 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.

6.3 Test Equipment List

Please see Appendix A

6.4 Test Results

From this data, the closest measurement (6 dB bandwidth) when compared to the specified limit, is 10330 kHz, which is above the minimum of 500 kHz.

6.5 Test Data

1 MBPS

Channel	20dB (MHz)	99% (MHz)	6dB (MHz)
1	16.06	13.89	10.33
6	16.03	13.99	10.33
11	16.08	13.85	10.33

6 MBPS

Channel	20dB (MHz)	99% (MHz)	6dB (MHz)
1	17.58	16.61	16.58
6	17.59	16.47	16.50
11	17.40	16.49	16.50

11 MBPS

Channel	20dB (MHz)	99% (MHz)	6dB (MHz)
1	15.45	13.68	11.49
6	15.35	13.76	11.43
11	15.82	13.67	11.58

Test Data Continued

24 MBPS

Channel	20dB (MHz)	99% (MHz)	6dB (MHz)
1	18.10	16.69	16.59
6	17.86	16.70	16.59
11	17.75	16.72	16.67

54 MBPS

Channel	20dB (MHz)	99% (MHz)	6dB (MHz)
1	18.67	16.73	16.67
6	18.46	16.65	16.67
11	18.85	16.75	16.67

MCS7

Channel	20dB (MHz)	99% (MHz)	6dB (MHz)
1	19.03	17.61	17.75
6	19.02	17.61	17.79
11	18.87	17.47	17.80

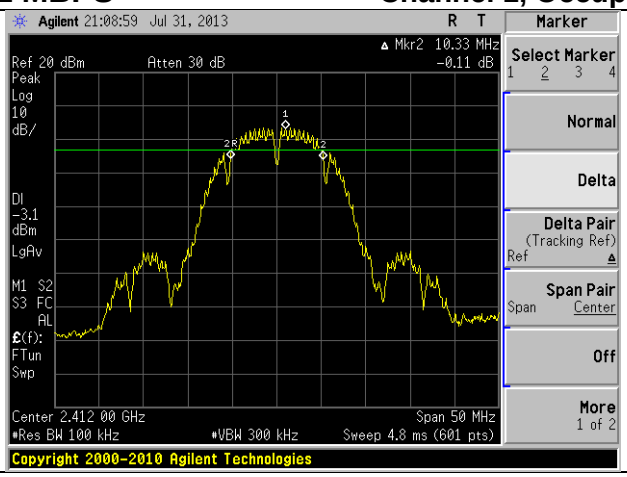
BLE

Channel	20dB (MHz)	99% (MHz)	6dB (MHz)
0	1.14	1.06	0.771
19	1.08	1.04	0.761
39	1.14	1.05	0.761

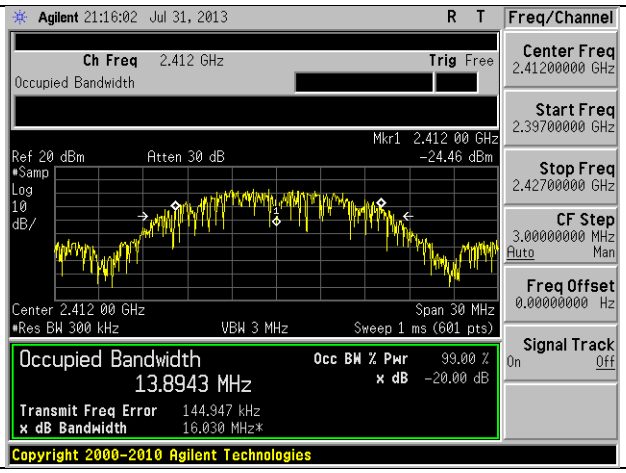
6.5 Screen Captures - OCCUPIED BANDWIDTH

1 MBPS

Channel 1, Occupied Bandwidth

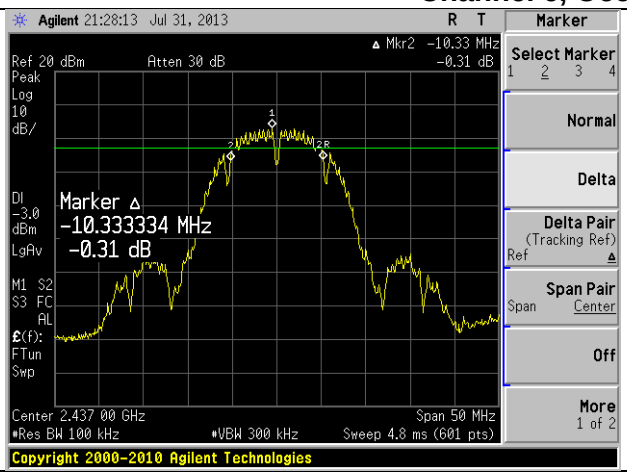


6 dB BW

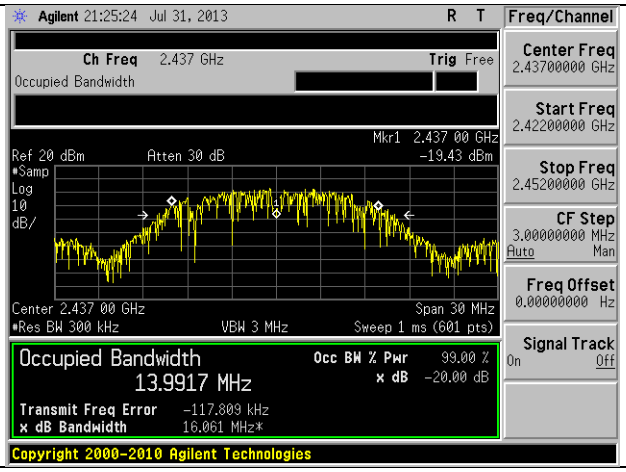


20 dB and 99% BW

Channel 6, Occupied Bandwidth

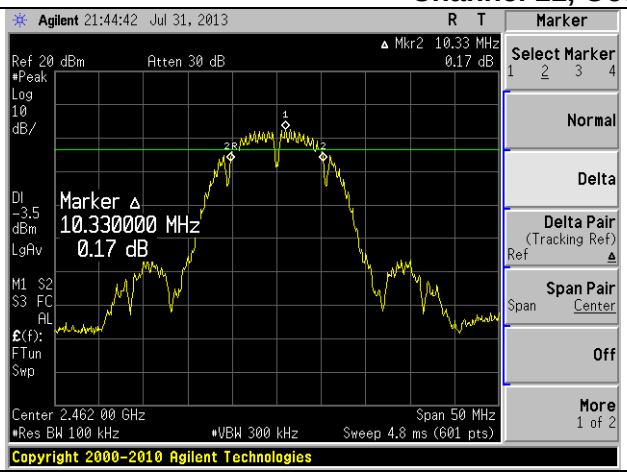


6 dB BW

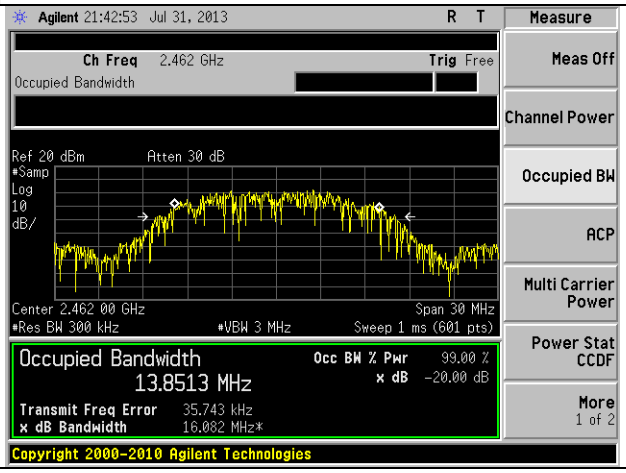


20 dB and 99% BW

Channel 11, Occupied Bandwidth



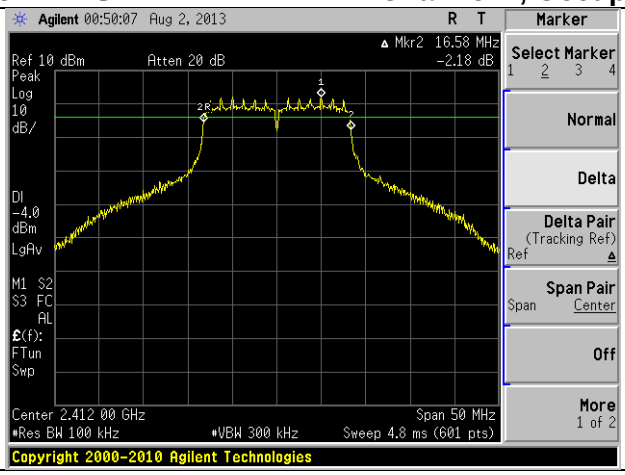
6 dB BW



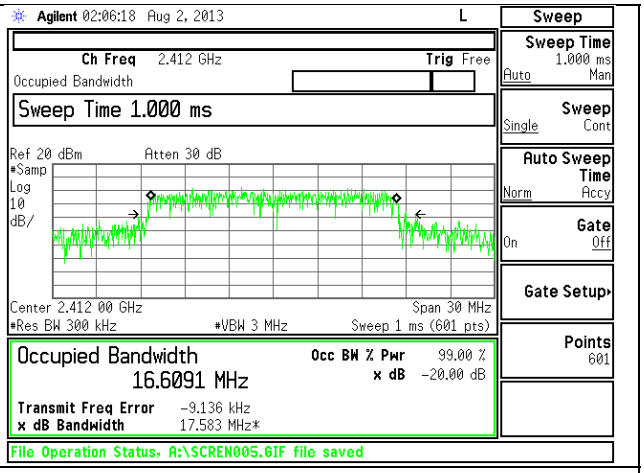
20 dB and 99% BW

6 MBPS

Channel 1, Occupied Bandwidth

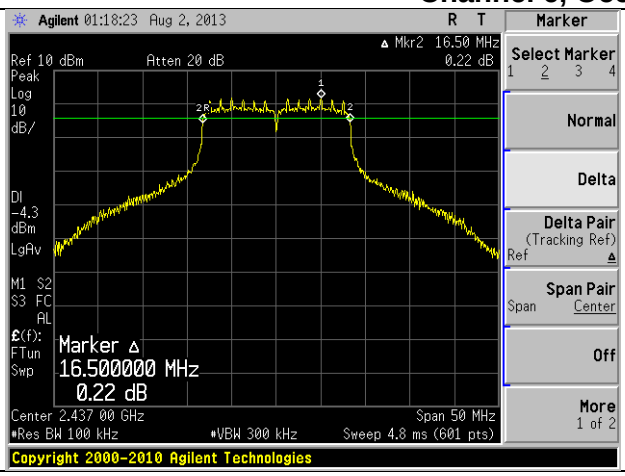


6 dB BW

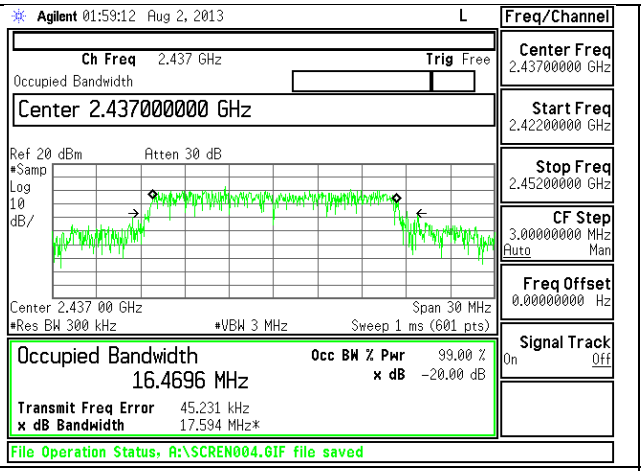


20 dB and 99% BW

Channel 6, Occupied Bandwidth

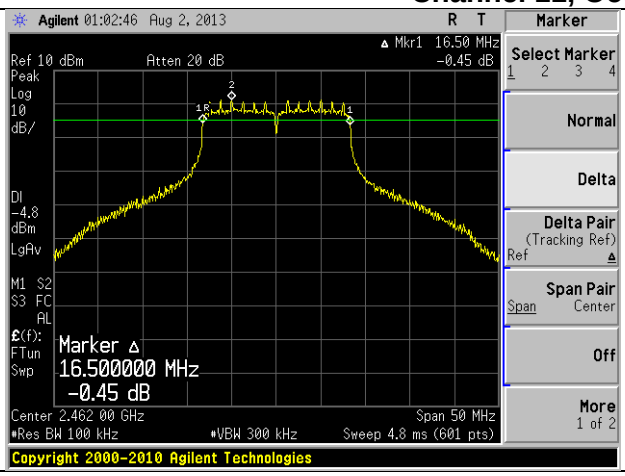


6 dB BW

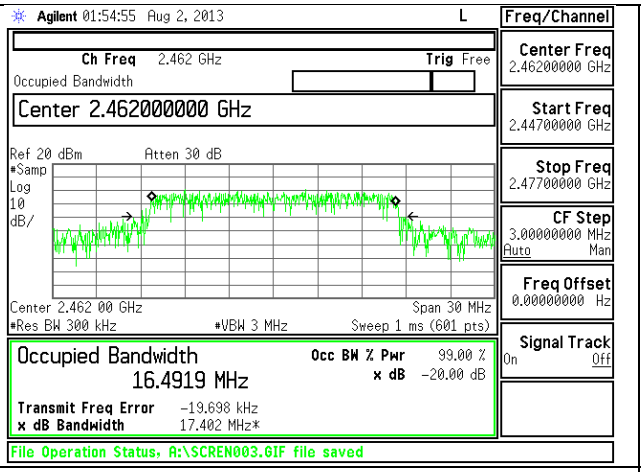


20 dB and 99% BW

Channel 11, Occupied Bandwidth



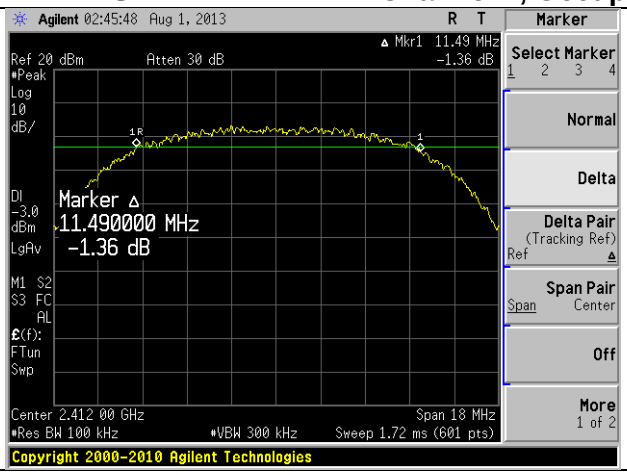
6 dB BW



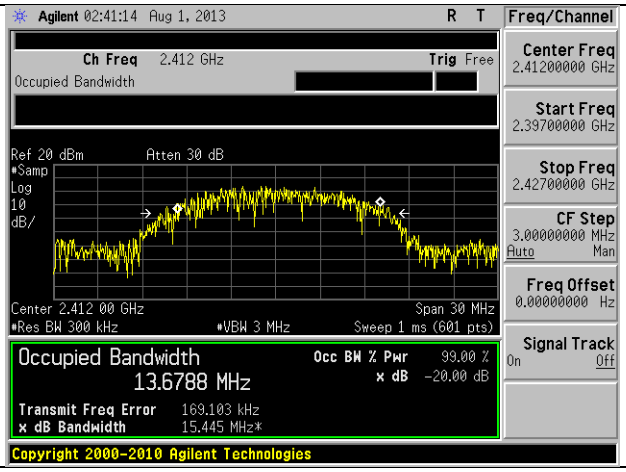
20 dB and 99% BW

11 MBPS

Channel 1, Occupied Bandwidth

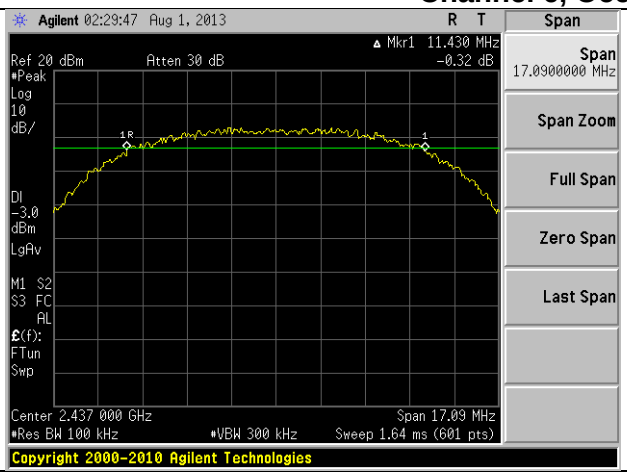


6 dB BW

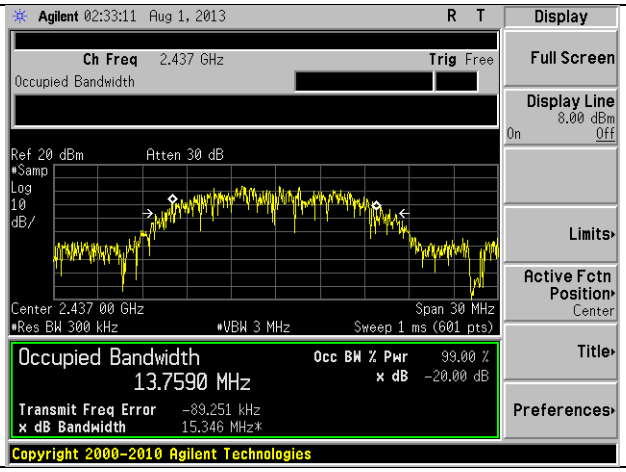


20 dB and 99% BW

Channel 6, Occupied Bandwidth

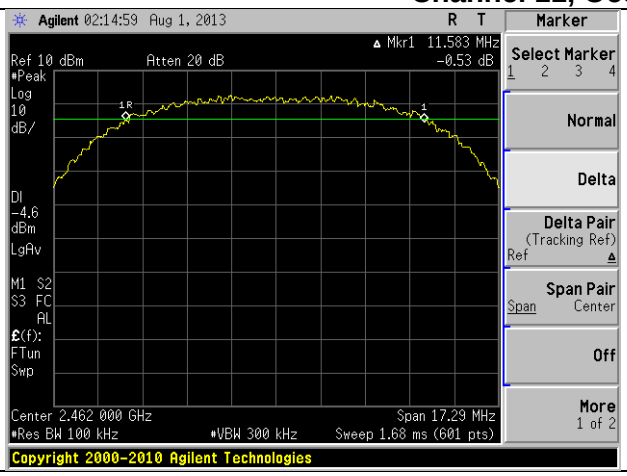


6 dB BW

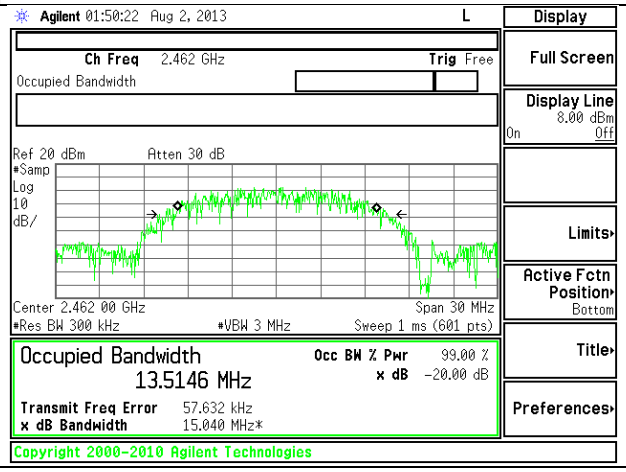


20 dB and 99% BW

Channel 11, Occupied Bandwidth



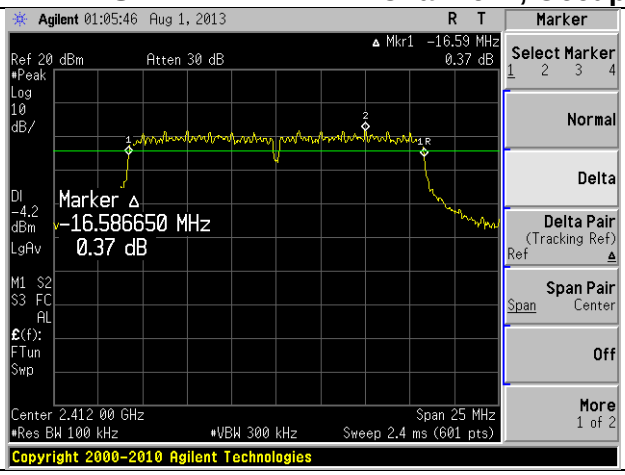
6 dB BW



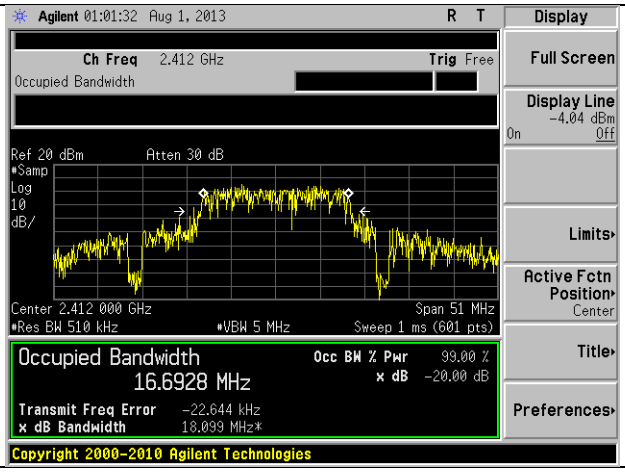
20 dB and 99% BW

24 MBPS

Channel 1, Occupied Bandwidth

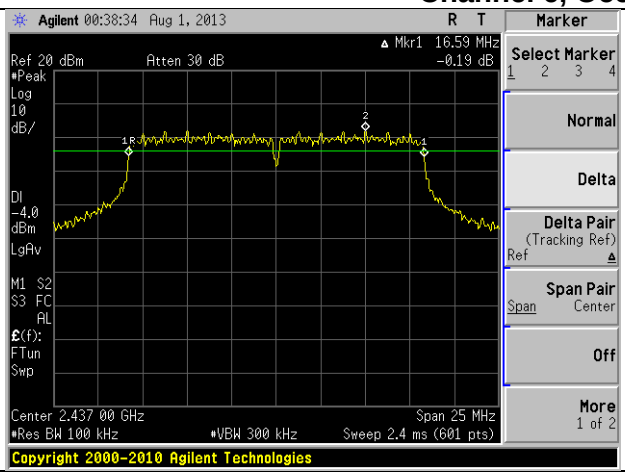


6 dB BW

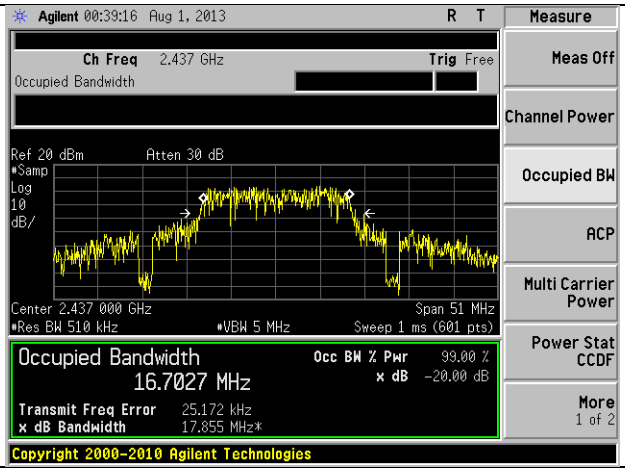


20 dB and 99% BW

Channel 6, Occupied Bandwidth

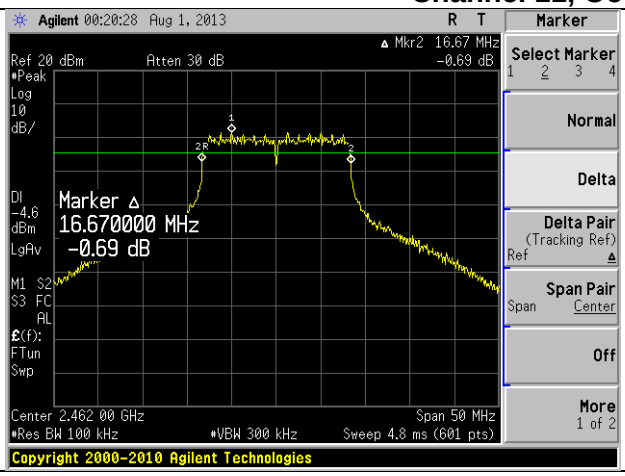


6 dB BW

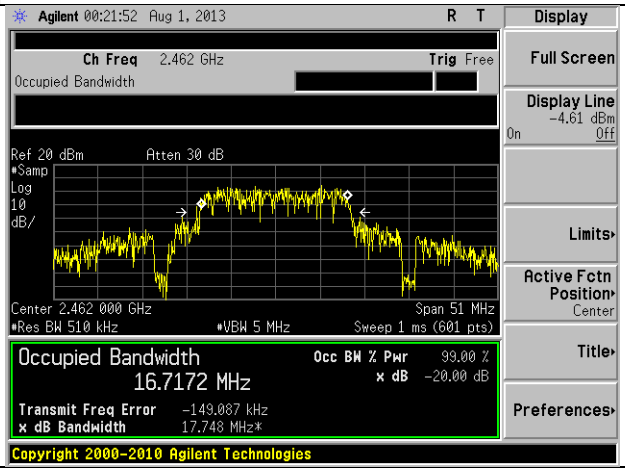


20 dB and 99% BW

Channel 11, Occupied Bandwidth



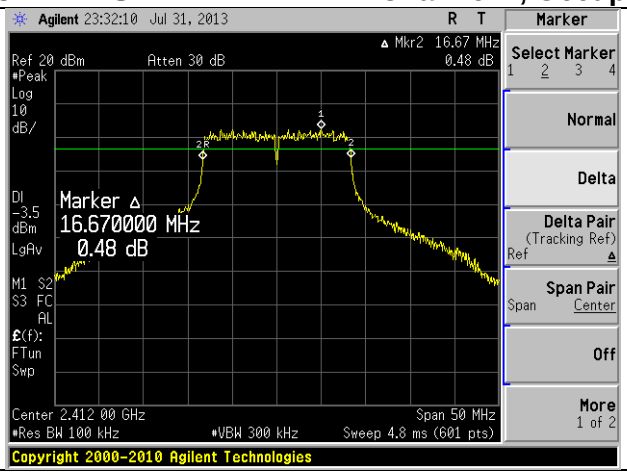
6 dB BW



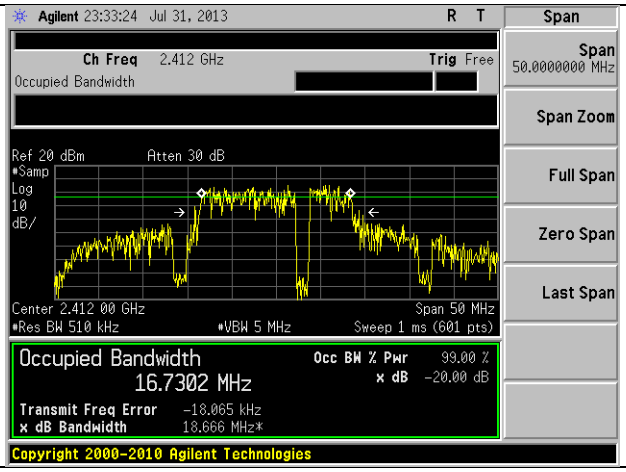
20 dB and 99% BW

54 MBPS

Channel 1, Occupied Bandwidth

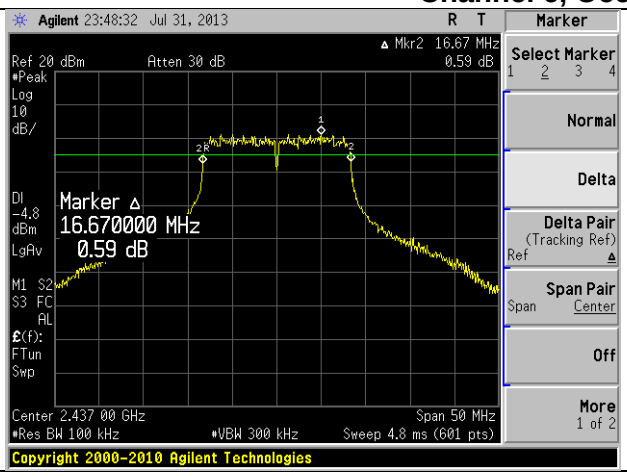


6 dB BW

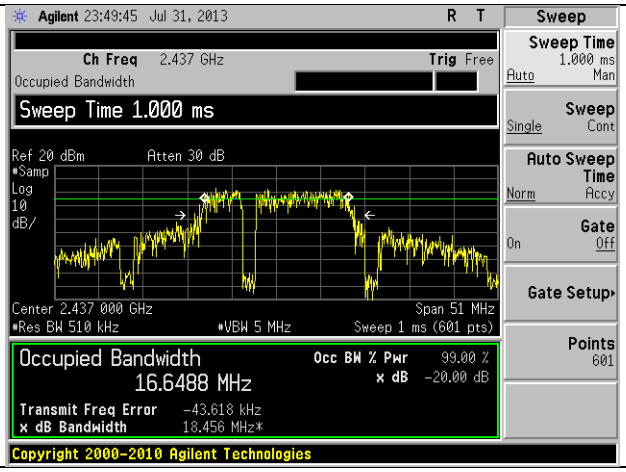


20 dB and 99% BW

Channel 6, Occupied Bandwidth

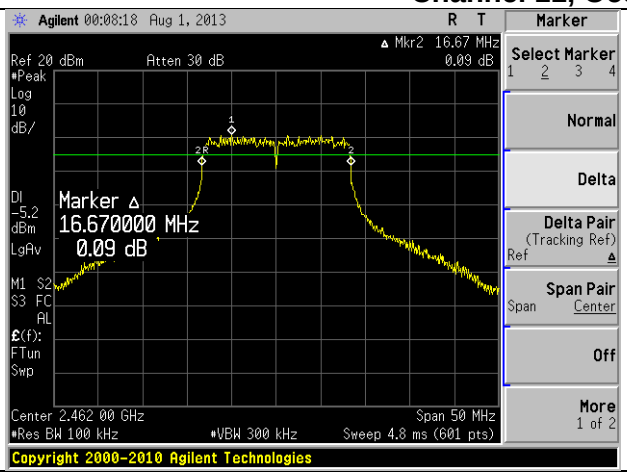


6 dB BW

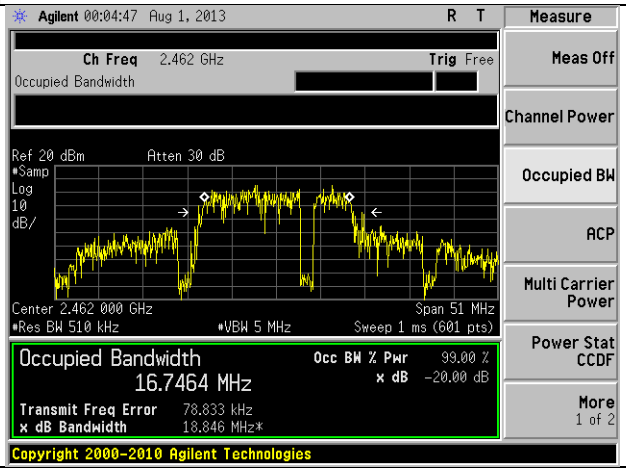


20 dB and 99% BW

Channel 11, Occupied Bandwidth

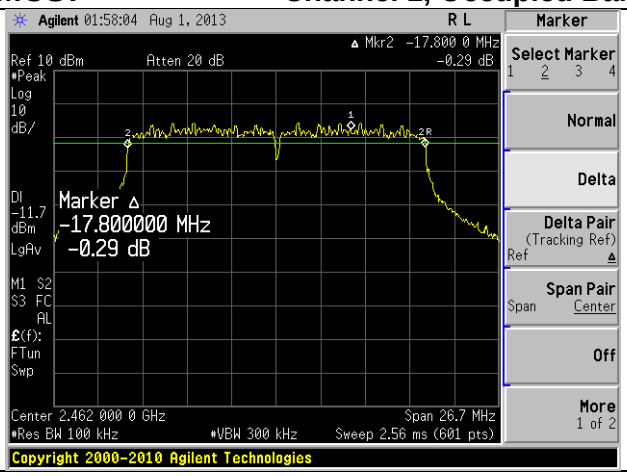


6 dB BW

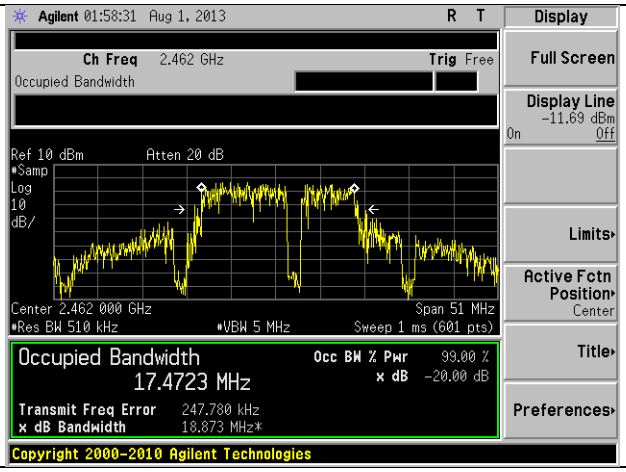


20 dB and 99% BW

MCS7 Channel 1, Occupied Bandwidth

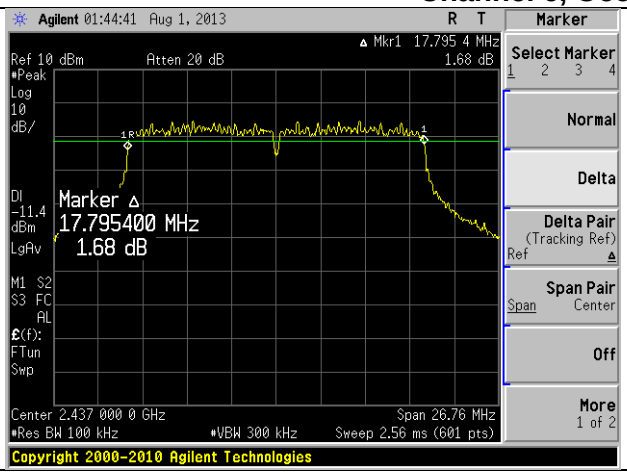


6 dB BW

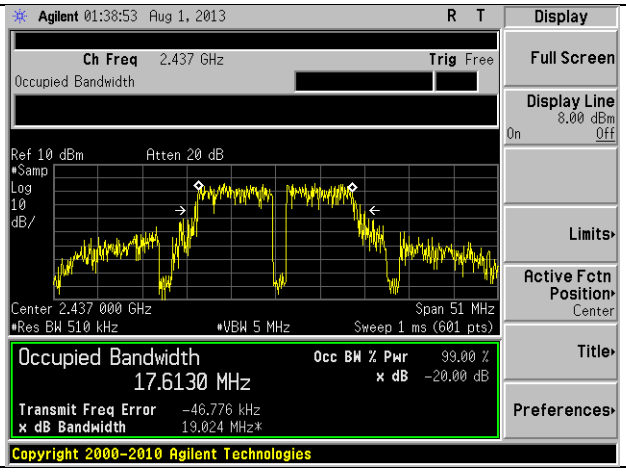


20 dB and 99% BW

Channel 6, Occupied Bandwidth

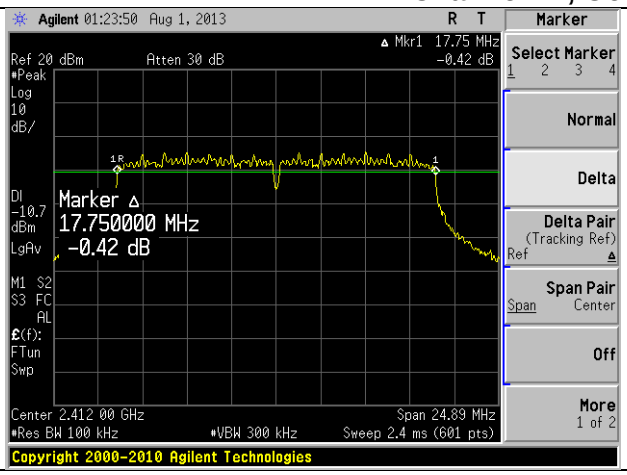


6 dB BW

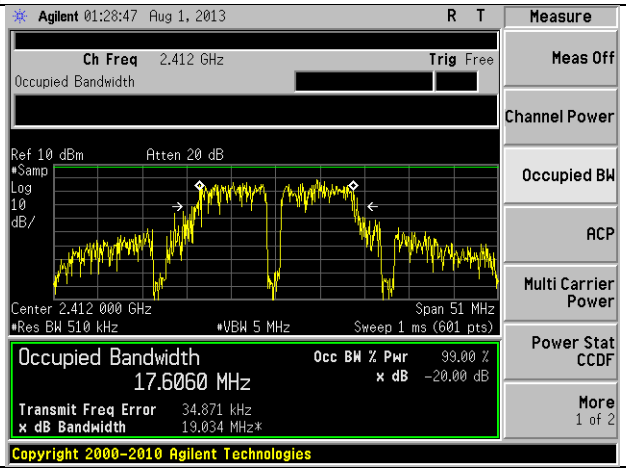


20 dB and 99% BW

Channel 11, Occupied Bandwidth

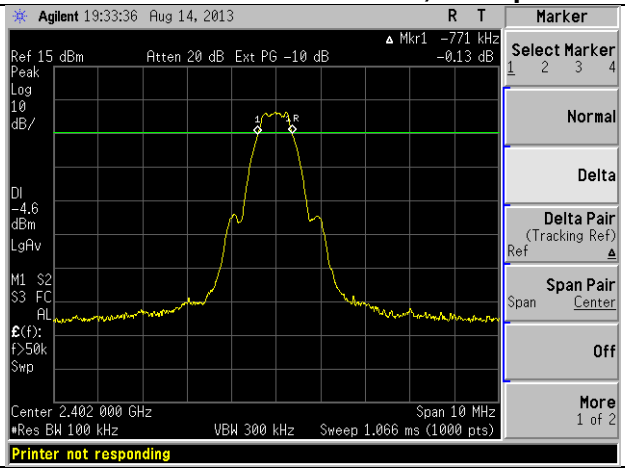


6 dB BW

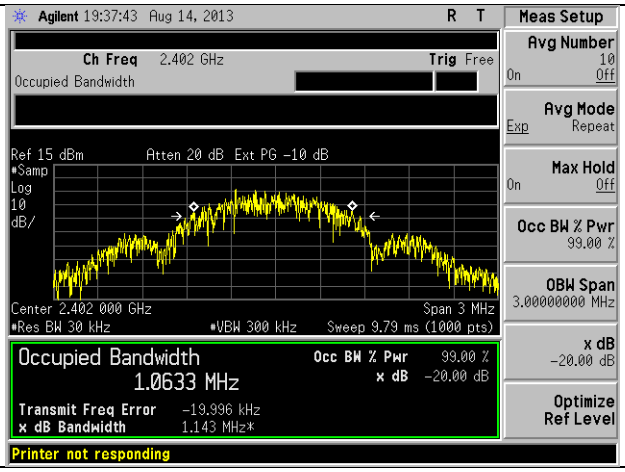


20 dB and 99% BW

BLE Channel 0, Occupied Bandwidth

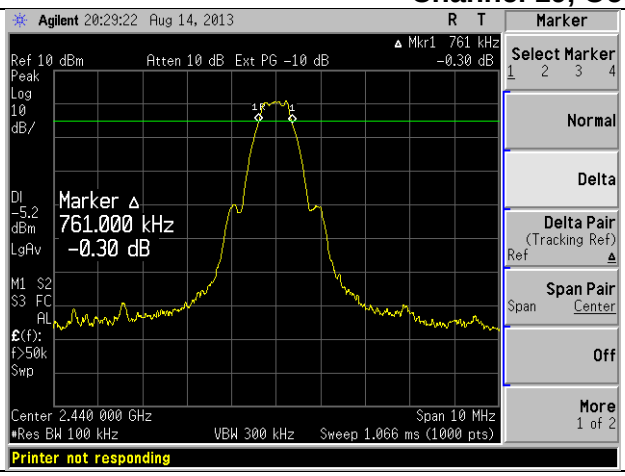


6 dB BW

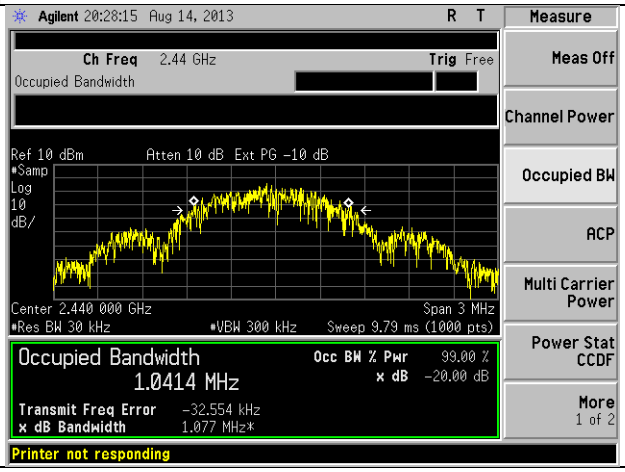


20 dB and 99% BW

Channel 19, Occupied Bandwidth

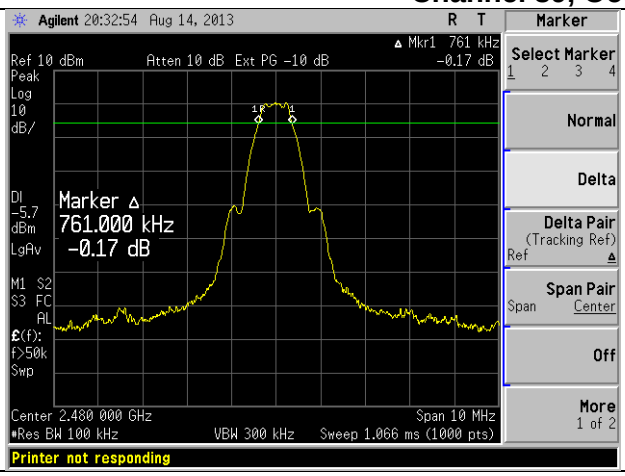


6 dB BW

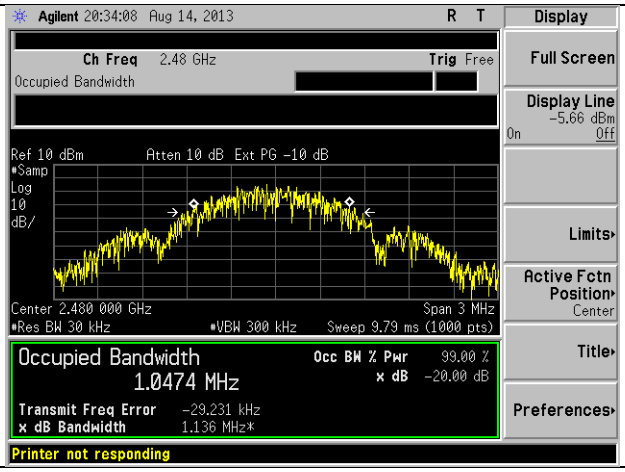


20 dB and 99% BW

Channel 39, Occupied Bandwidth



6 dB BW



20 dB and 99% BW

EXHIBIT 7 BAND-EDGE MEASUREMENTS

7.1 Limits

For a 2.4 GHz Transmitter:

The 2310-2390 MHz Lower Band-Edge limit, in this case, would be + 54 dBµV/m at 3m.

The 2483.5-2500 MHz Upper Band-Edge limit, in this case, would be + 54 dBµV/m at 3m.

7.2 Method of Measurements

The test setup was assembled in accordance with 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 transmit mode. The unit was operated on the low and high channels.

The following screen captures demonstrate compliance of the intentional radiator in 15.205 restricted bands 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.

7.3 Test Equipment List

Please see Appendix A

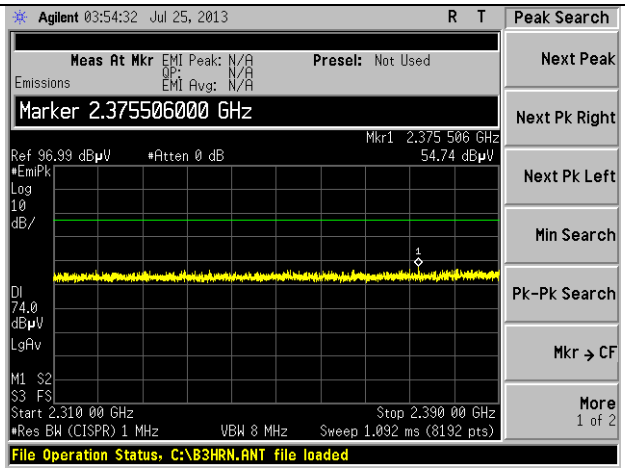
7.4 Test Results

The 15.205 frequencies do not exceed the 15.247 radiated limit of 54dBuV/m. The narrowest margin observed is 1.67 dB

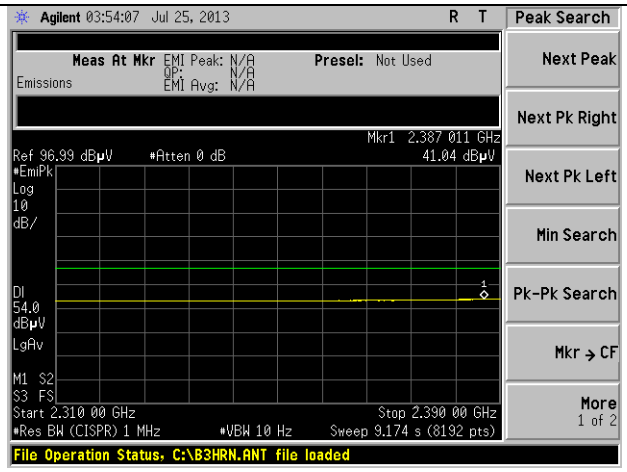
7.5 Test Data Screen Captures

Screen Capture Demonstrating Compliance at the Lower Band-Edge

1 MBPS

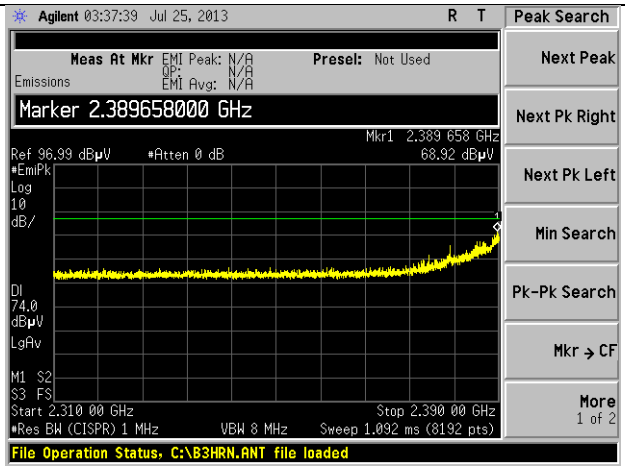


Peak

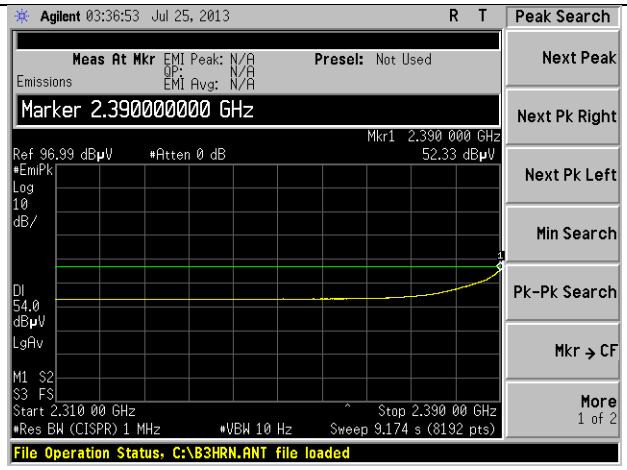


Average

6 MBPS

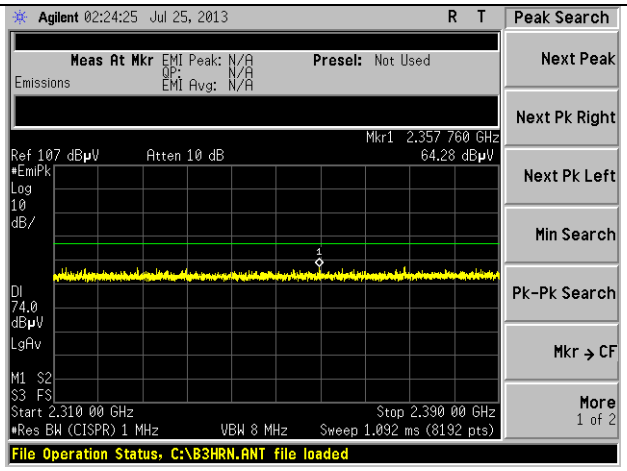
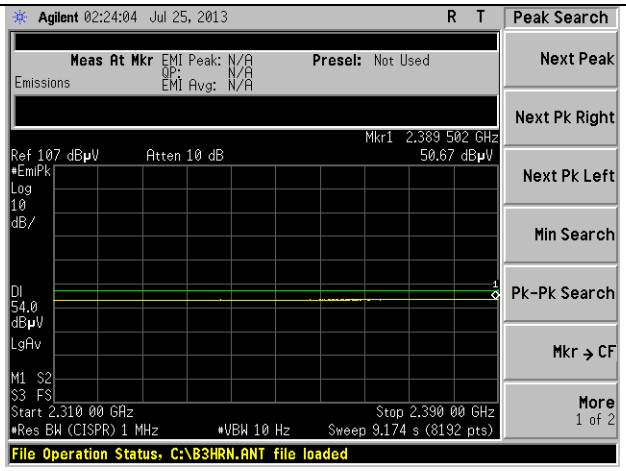


Peak

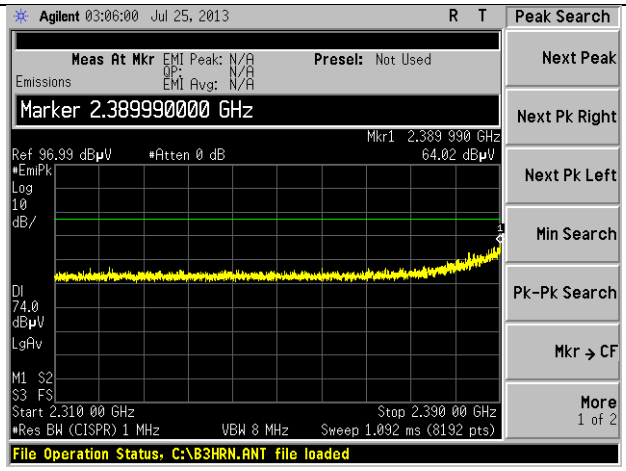


Average

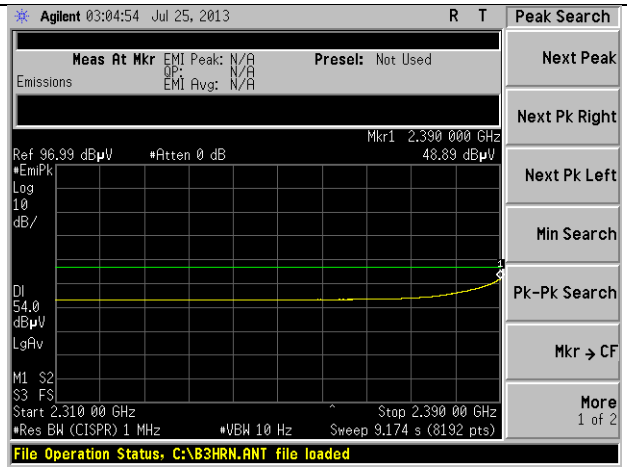
11 MBPS

	
Peak	Average

24 MBPS

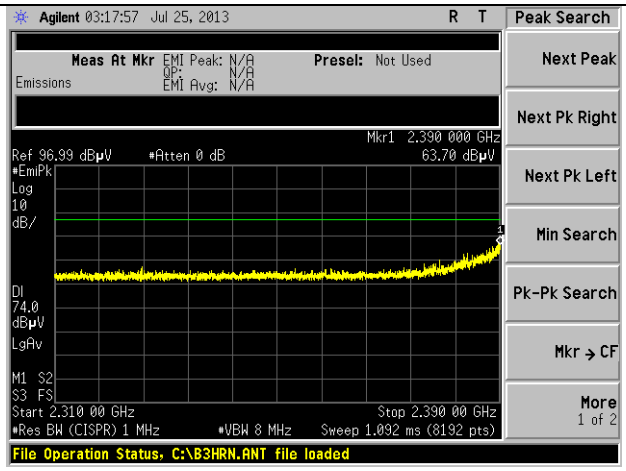


Peak

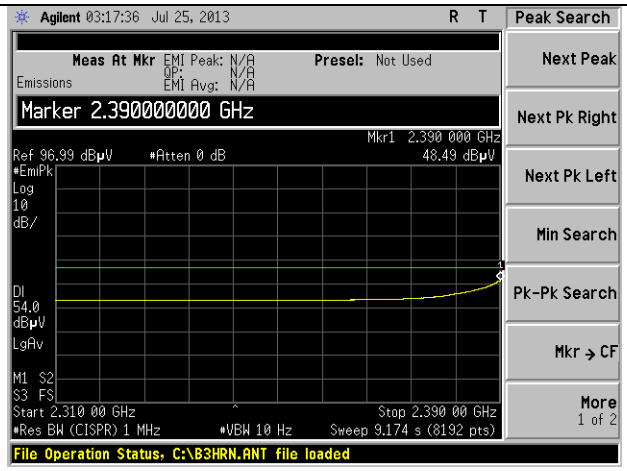


Average

54 MBPS

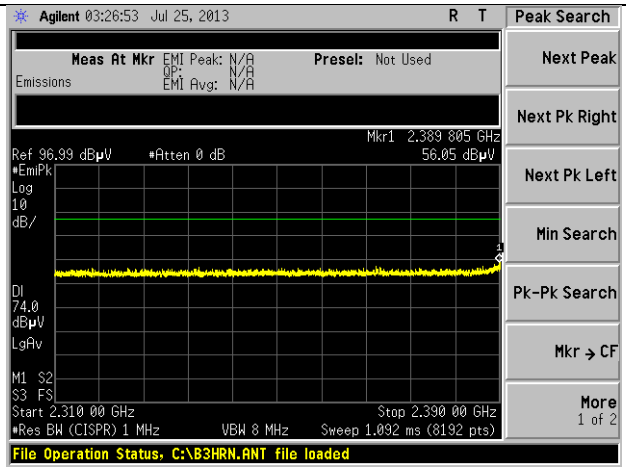


Peak

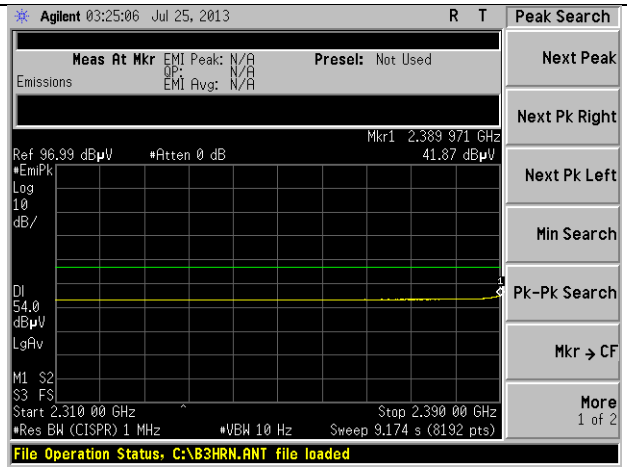


Average

MCS7

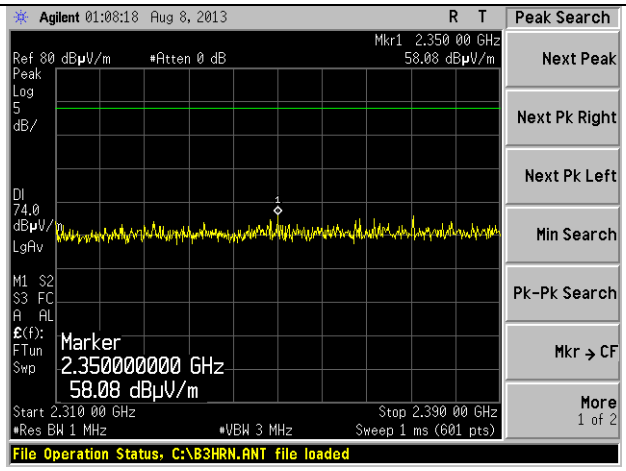


Peak

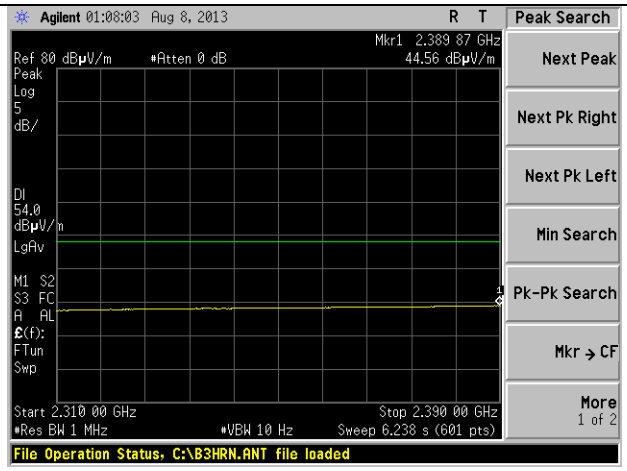


Average

BLE



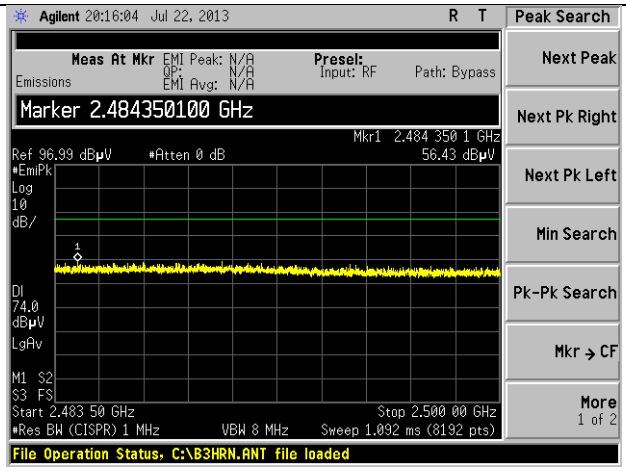
Peak



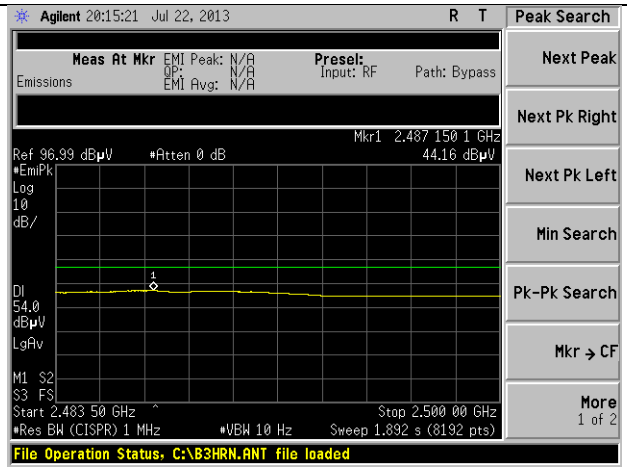
Average

Screen Captures Demonstrating Compliance at the Higher Band-Edge

1 MBPS

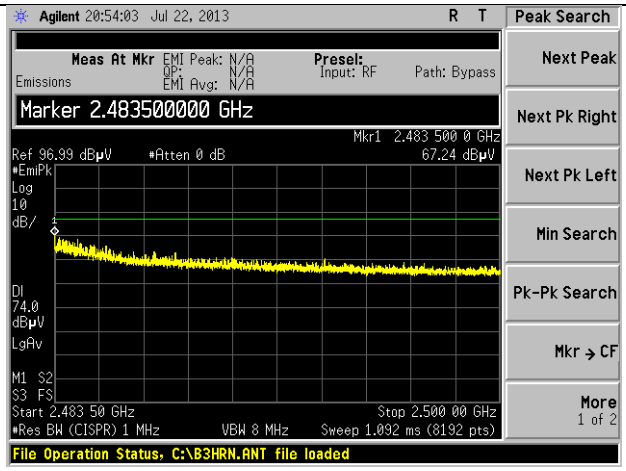


Peak

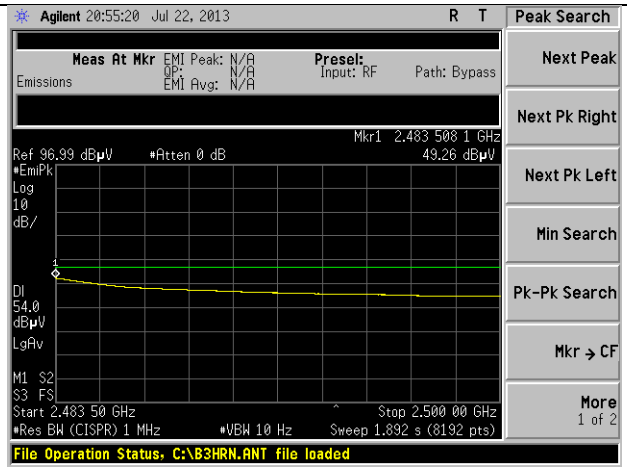


Average

6 MBPS

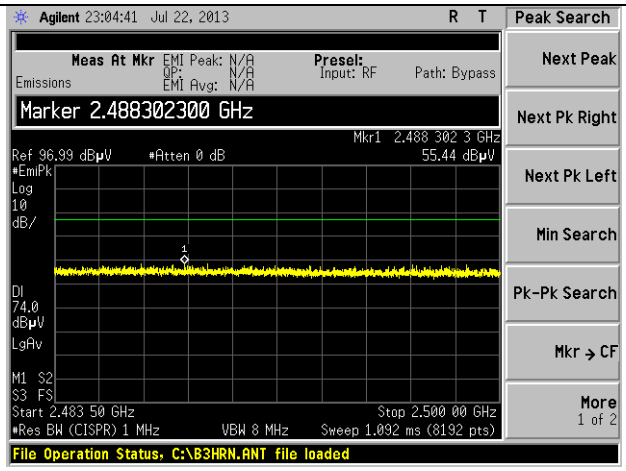


Peak

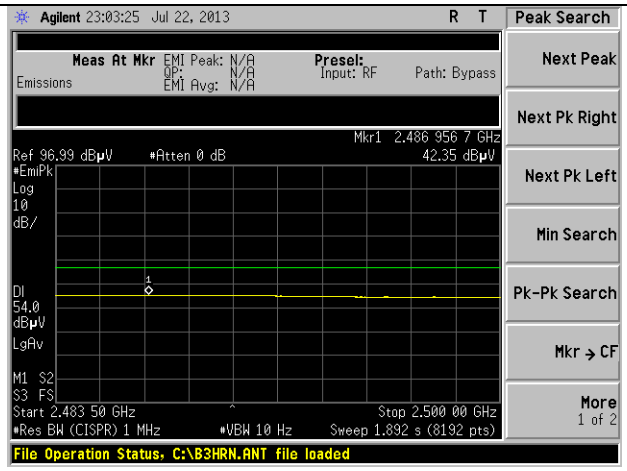


Average

11 MBPS

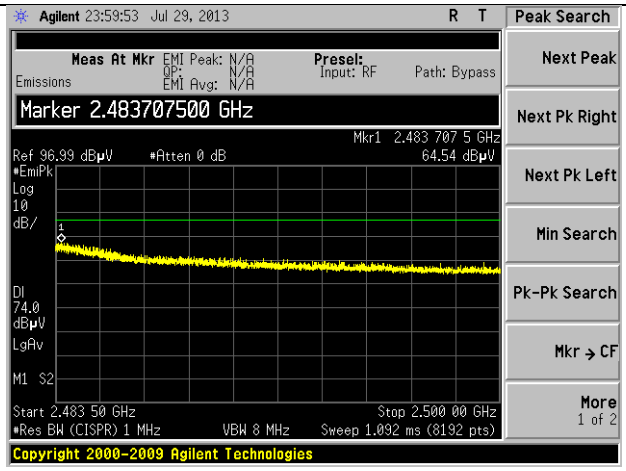


Peak

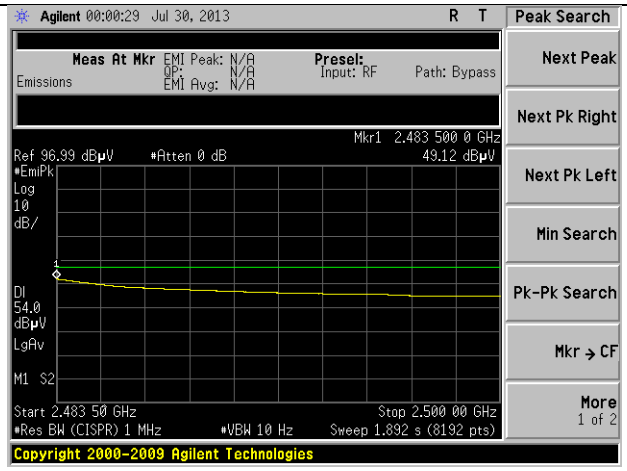


Average

24 MBPS

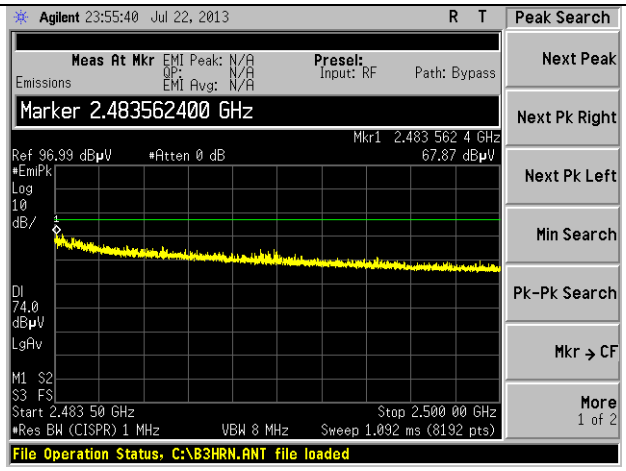


Peak

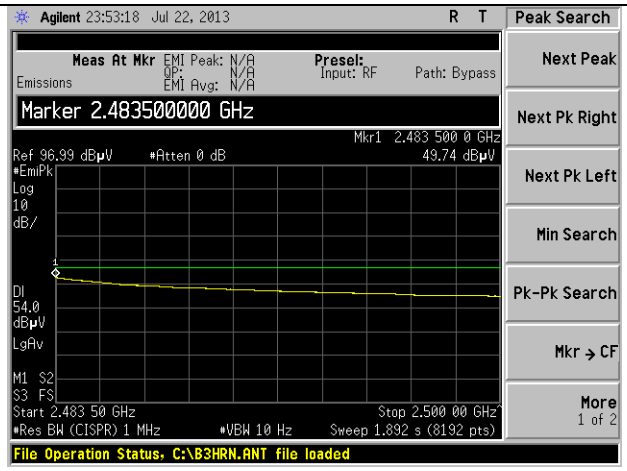


Average

54 MBPS

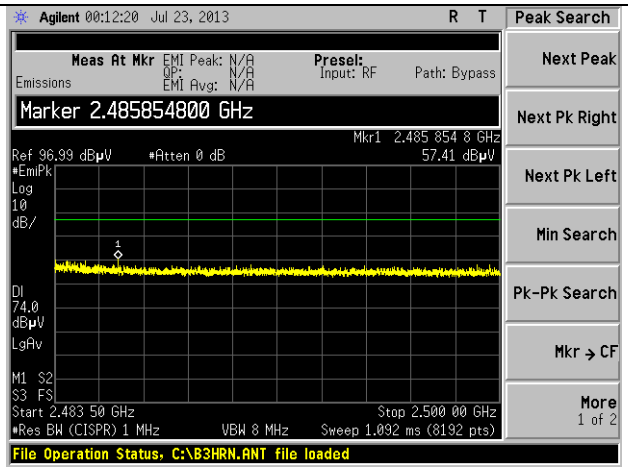


Peak

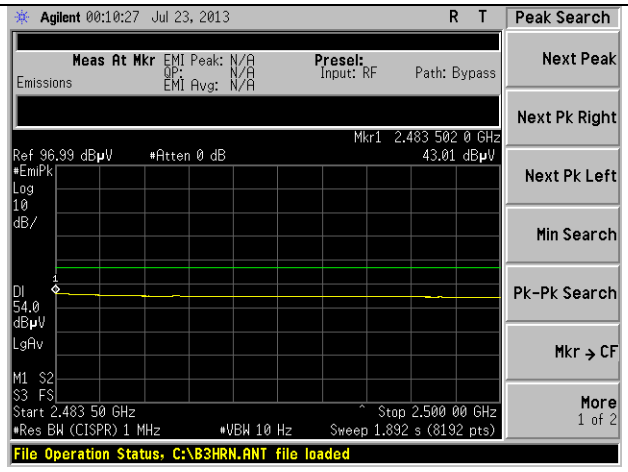


Average

MCS7

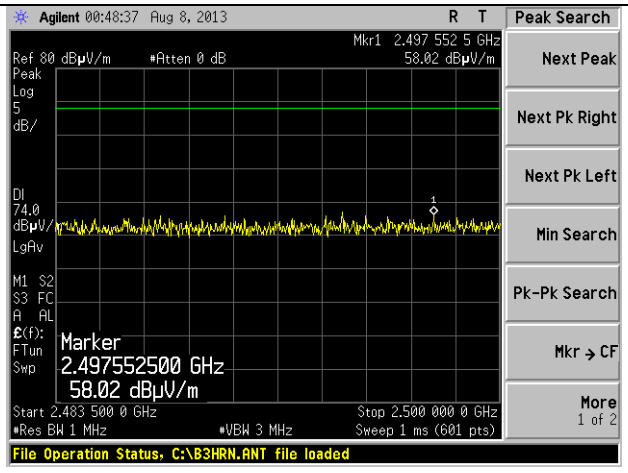


Peak

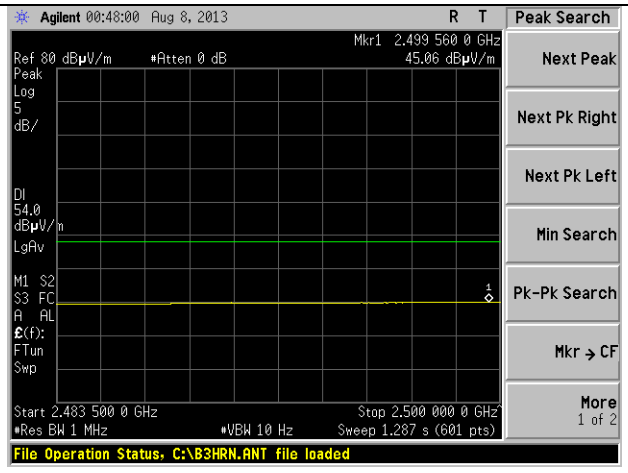


Average

BLE



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 using a short RF cable to the spectrum analyzer. The unit was configured to run in a continuous modulated transmit mode. The spectrum analyzer was used with resolution and video bandwidths set to 1 MHz, and a span of 1.5 times the DTS bandwidth, with measurements from a peak detector and calculated with a band-power integration feature built into the spectrum analyzer.

8.2 Test Equipment List

Please see Appendix A

8.3 Test Results

From this data, the closest measurement when compared to the specified limit is 23.2 dBm, which is below the limit of 30.0 dBm by 6.8 dBm.

8.4 Test Data

1 MBPS

Chan	Power (dBm)	Cable Loss (dB)	Adjusted Value (dBm)	Limit	Margin
1	15.6	1.0	16.6	30.0	13.4
6	15.1	1.0	16.1	30.0	13.9
11	14.4	1.0	15.4	30.0	14.6

6 MBPS

Chan	Power (dBm)	Cable Loss (dB)	Adjusted Value (dBm)	Limit	Margin
1	17.0	1.0	18.0	30.0	12.0
6	17.1	1.0	18.1	30.0	11.9
11	16.3	1.0	17.3	30.0	12.7

11 MBPS

Chan	Power (dBm)	Cable Loss (dB)	Adjusted Value (dBm)	Limit	Margin
1	18.9	1.0	19.9	30	10.1
6	19.0	1.0	20.0	30	10.0
11	18.1	1.0	19.1	30	10.9

24 MBPS

Chan	Power (dBm)	Cable Loss (dB)	Adjusted Value (dBm)	Limit	Margin
1	21.3	1.0	22.3	30	7.7
6	21.1	1.0	22.1	30	7.9
11	21.2	1.0	22.2	30	7.8

54 MBPS

Chan	Power (dBm)	Cable Loss (dB)	Adjusted Value (dBm)	Limit	Margin
1	22.2	1.0	23.2	30	6.8
6	21.2	1.0	22.2	30	7.8
11	22.2	1.0	23.2	30	6.8

MCS7

Chan	Power (dBm)	Cable Loss (dB)	Adjusted Value (dBm)	Limit	Margin
1	15.4	1.0	16.4	30	13.6
6	14.3	1.0	15.3	30	14.7
11	14.1	1.0	15.1	30	14.9

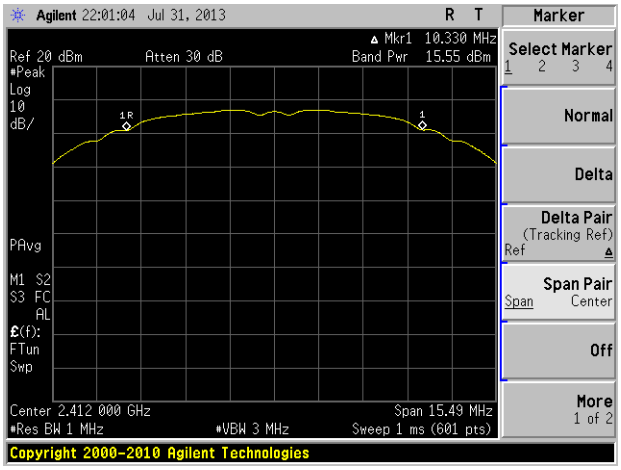
BLE

Chan	Power (dBm)	Cable Loss (dB)	Adjusted Value (dBm)	Limit	Margin
1	2.0	1.0	3.0	30.0	27.0
6	1.5	1.0	2.5	30.0	27.5
11	1.0	1.0	2.0	30.0	28.0

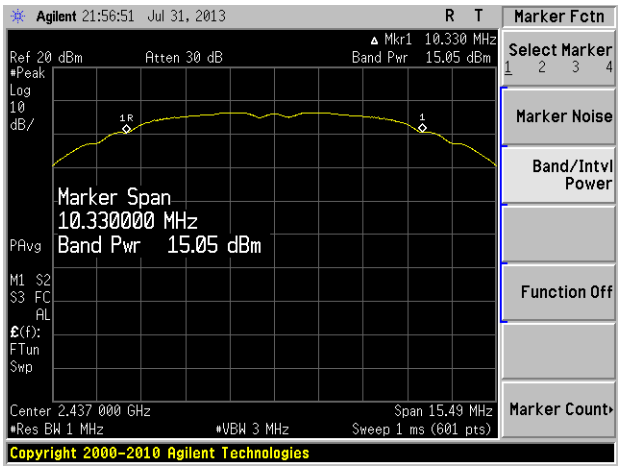
8.4 Screen Captures – Power Output (Conducted)

1 MBPS

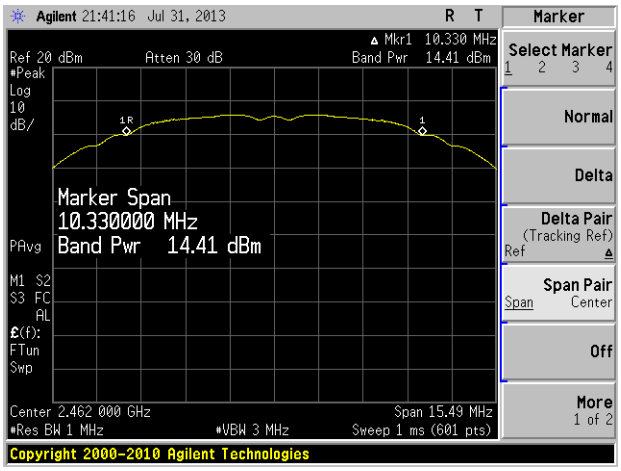
Channel 1



Channel 6

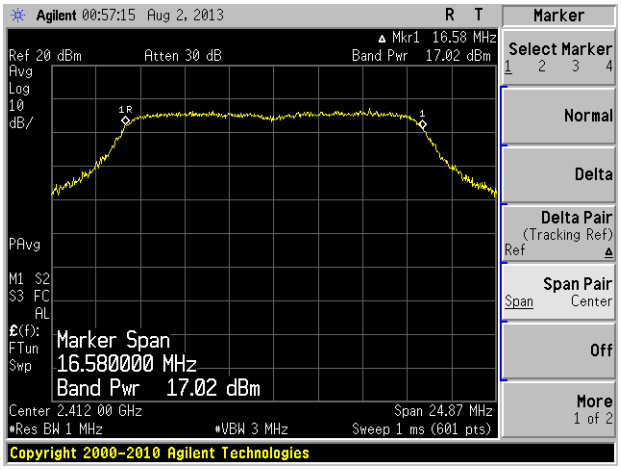


Channel 11

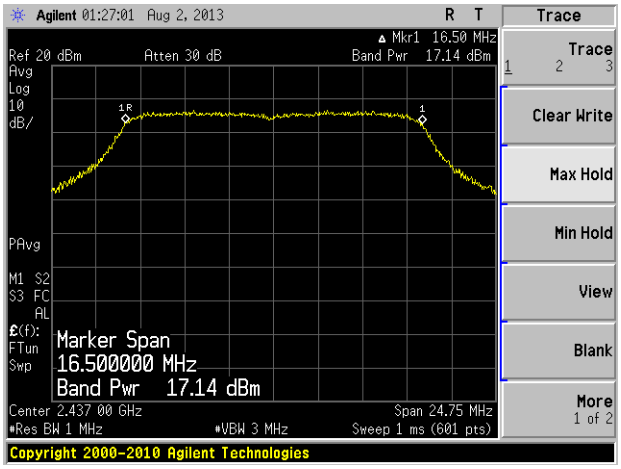


6 MBPS

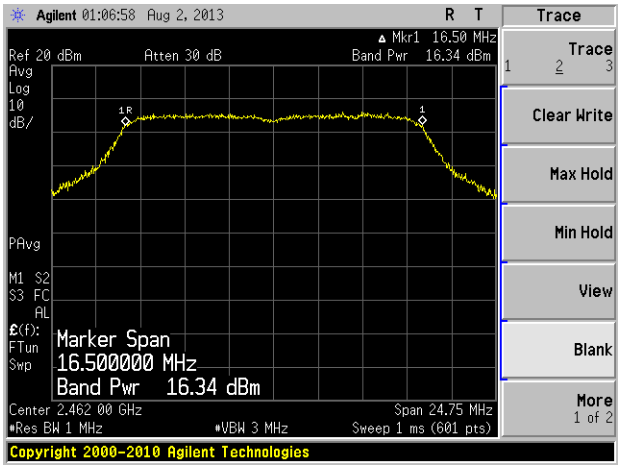
Channel 1



Channel 6

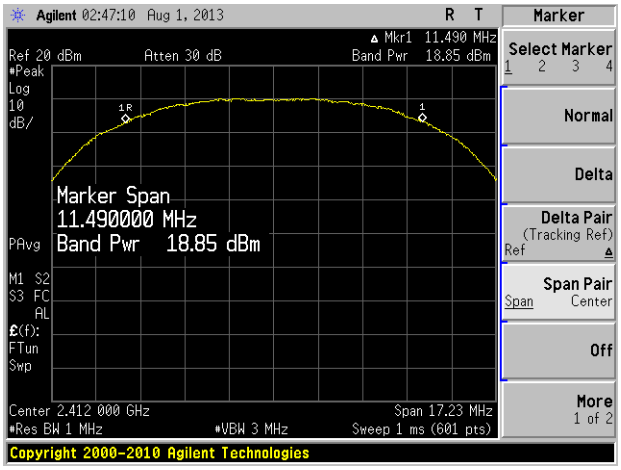


Channel 11

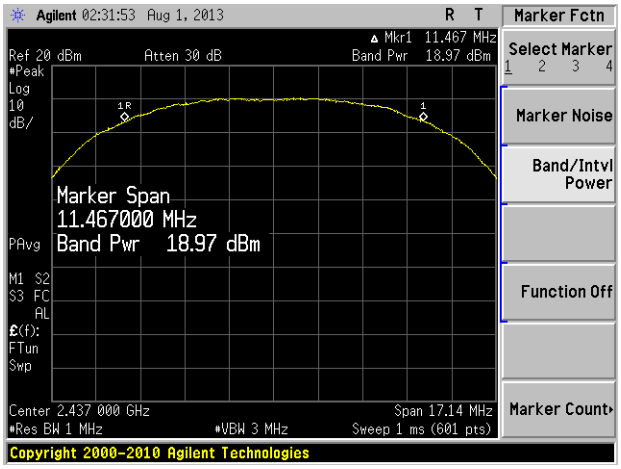


11 MBPS

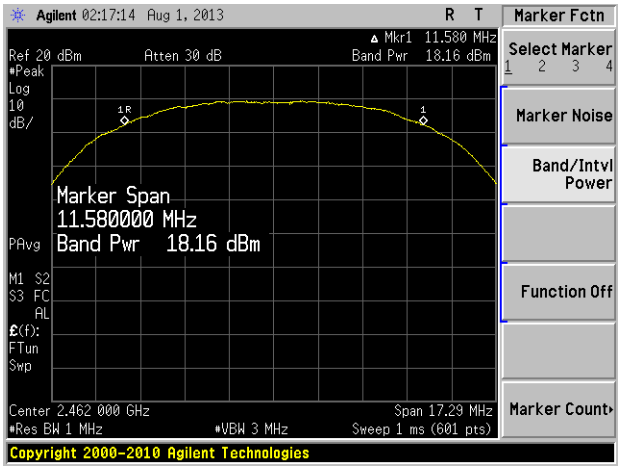
Channel 1



Channel 6

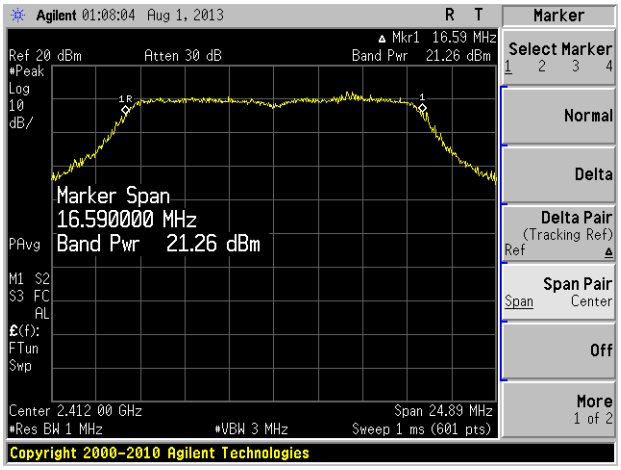


Channel 11

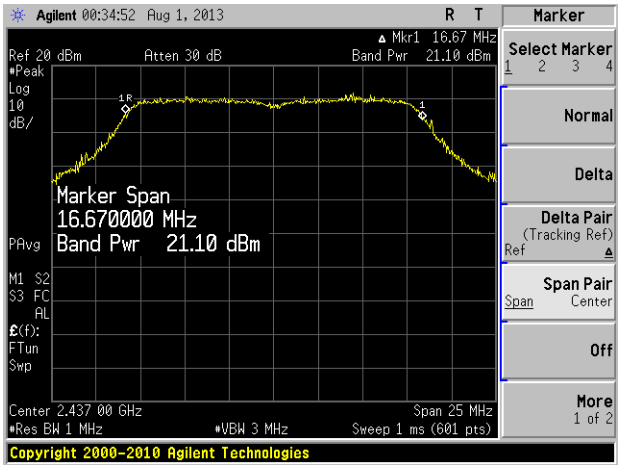


24 MBPS

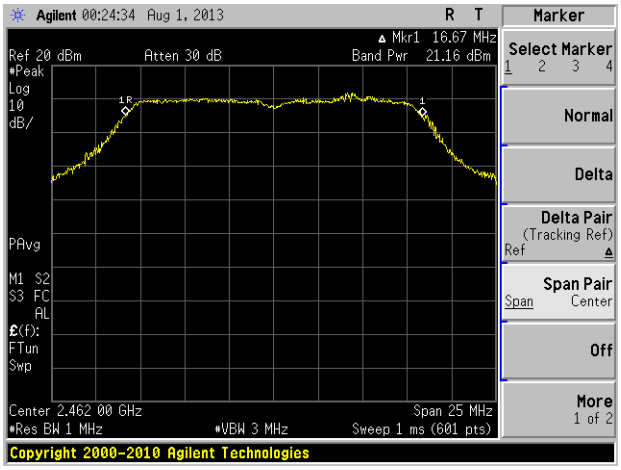
Channel 1



Channel 6

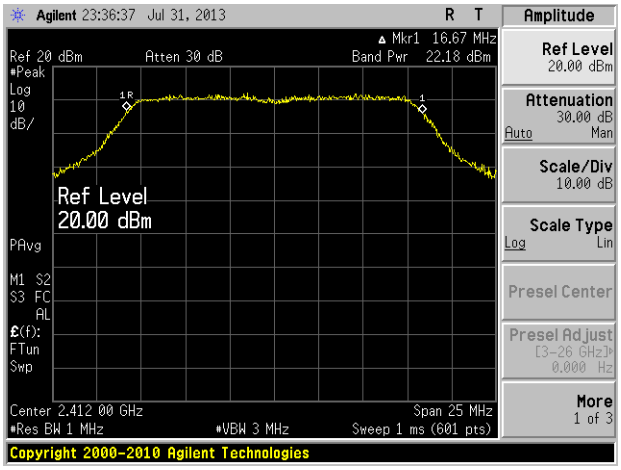


Channel 11

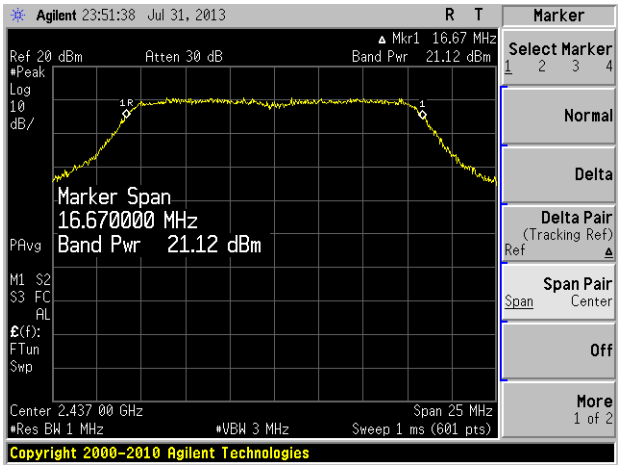


54 MBPS

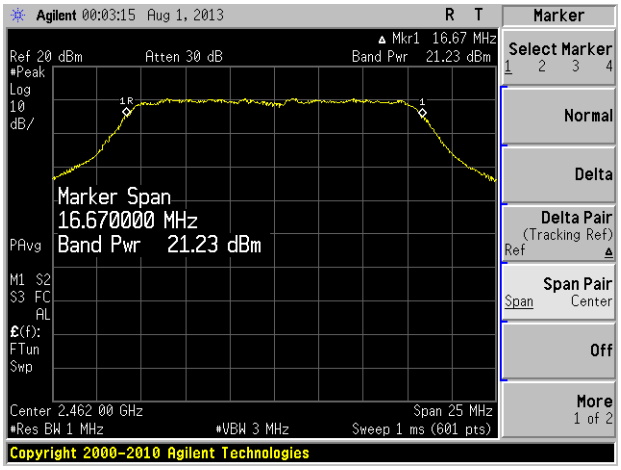
Channel 1



Channel 6

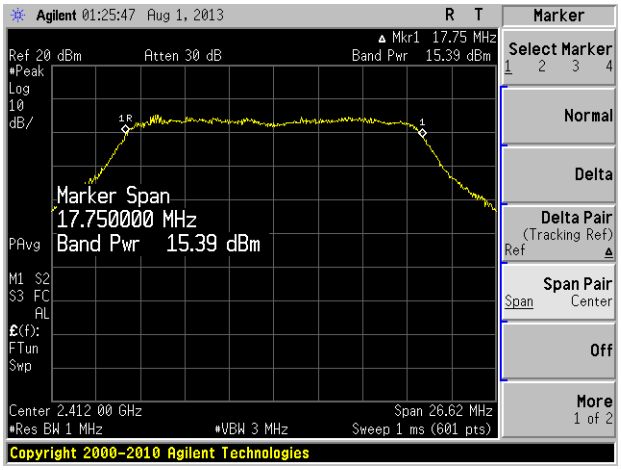


Channel 11

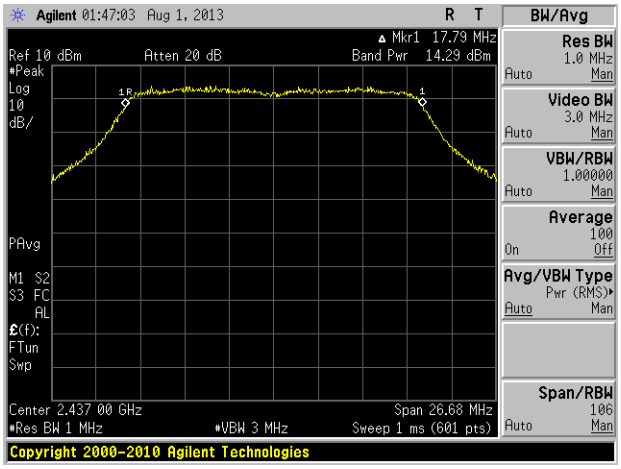


MCS7

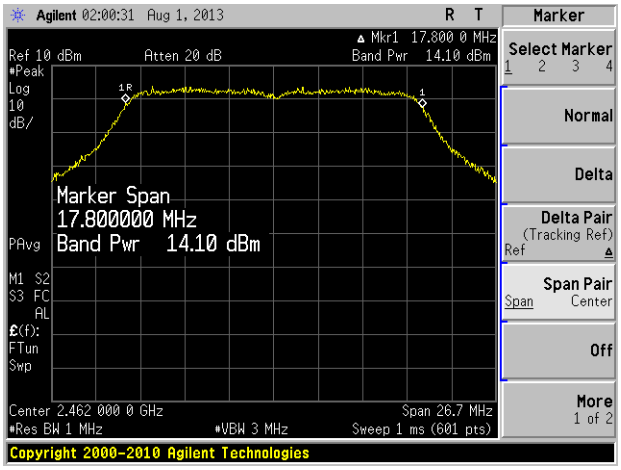
Channel 1



Channel 6

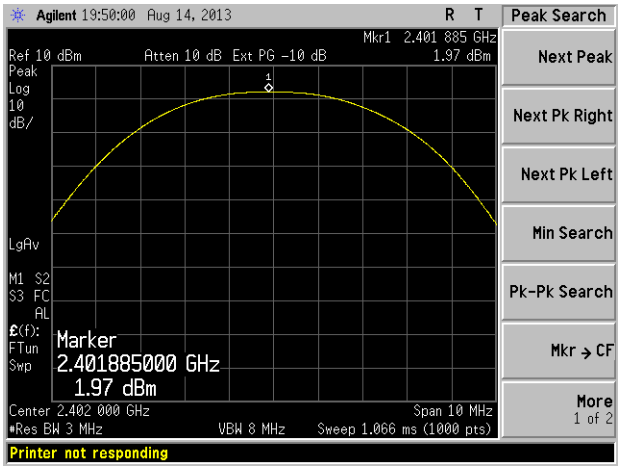


Channel 11

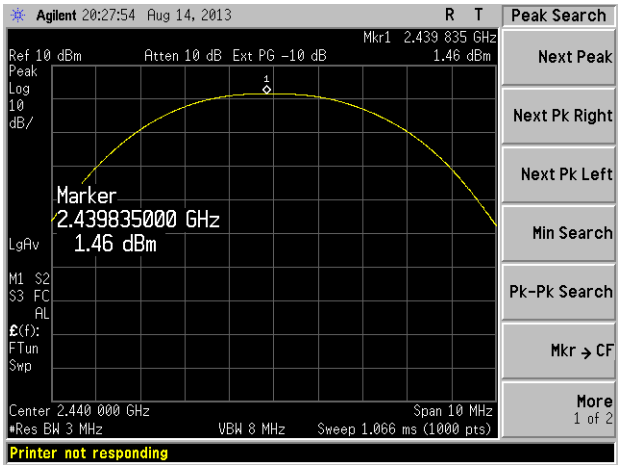


BLE

Channel 0



Channel 19



Channel 39

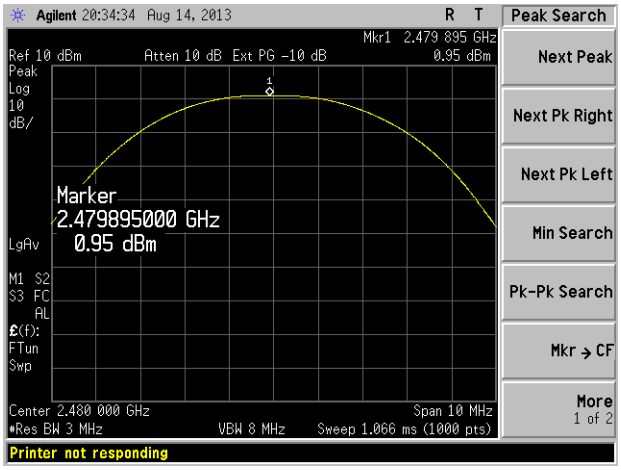


EXHIBIT 9 POWER SPECTRAL DENSITY: 15.247(e)

9.1 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) and RSS 210 A8.2(b), 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 following KDB 558074 D01 DTS Meas Guidance V03r01.

9.2 Test Equipment List

Please see Appendix A

9.3 Test Results

The highest density was found to be no greater than 3.4 dBm, which is under the allowable limit by 4.6 dB.

9.4 Test Data

1 MBPS

Chan	PSD/100kHz	Cable Loss (dB)	Adjusted Value (dBm)	limit	Margin
1	3.4	1.0	4.4	8.0	3.6
6	2.7	1.0	3.7	8.0	4.3
11	2.5	1.0	3.5	8.0	5.5

6 MBPS

Chan	PSD/100kHz	Cable Loss (dB)	Adjusted Value (dBm)	limit	Margin
1	1.8	1.0	2.8	8.0	5.2
6	1.8	1.0	2.8	8.0	5.2
11	1.0	1.0	2.0	8.0	6.0

11 MBPS

Chan	PSD/100kHz	Cable Loss (dB)	Adjusted Value (dBm)	limit	Margin
1	3.0	1.0	4.0	8.0	4.0
6	2.8	1.0	3.8	8.0	4.2
11	2.3	1.0	3.3	8.0	4.7

24 MBPS

Chan	PSD/100kHz	Cable Loss (dB)	Adjusted Value (dBm)	limit	Margin
1	1.8	1.0	2.8	8.0	6.2
6	1.8	1.0	2.8	8.0	6.2
11	1.3	1.0	2.3	8.0	6.7

54 MBPS

Chan	PSD/100kHz	Cable Loss (dB)	Adjusted Value (dBm)	limit	Margin
1	2.5	1.0	3.5	8.0	4.5
6	1.4	1.0	2.4	8.0	5.6
11	0.7	1.0	1.7	8.0	6.3

MCS7

Chan	PSD/100kHz	Cable Loss (dB)	Adjusted Value (dBm)	limit	Margin
1	-5.6	1.0	-4.6	8.0	12.6
6	-5.5	1.0	-4.5	8.0	12.5
11	-4.6	1.0	-3.6	8.0	11.6

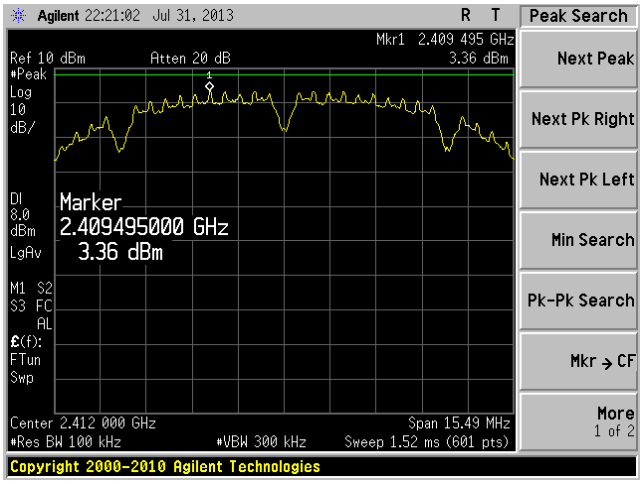
BLE

Chan	PSD/100kHz	Cable Loss (dB)	Adjusted Value (dBm)	limit	Margin
1	1.1	1.0	2.1	8.0	5.9
6	0.6	1.0	1.6	8.0	6.4
11	0.1	1.0	1.1	8.0	6.9

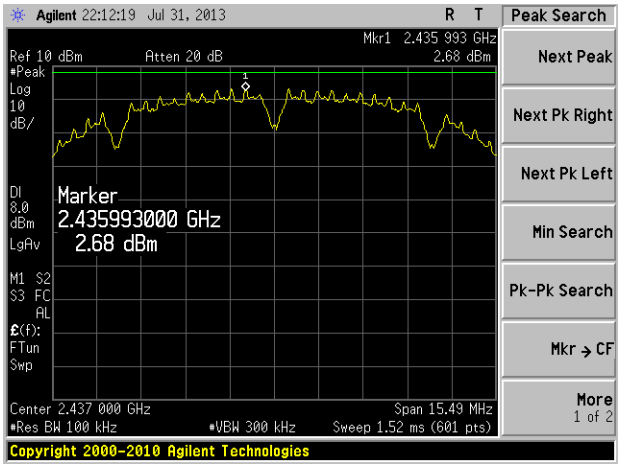
9.4 Screen Captures – Power Spectral Density

1 MBPS

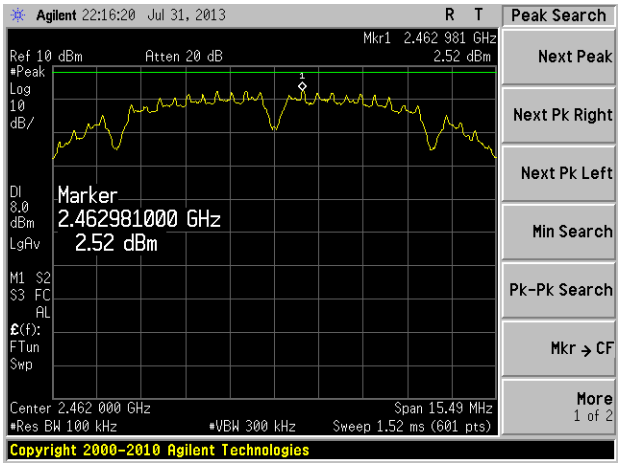
Channel 1



Channel 6

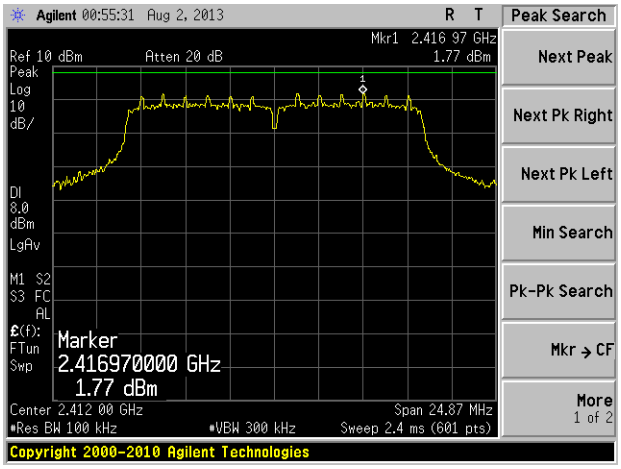


Channel 11

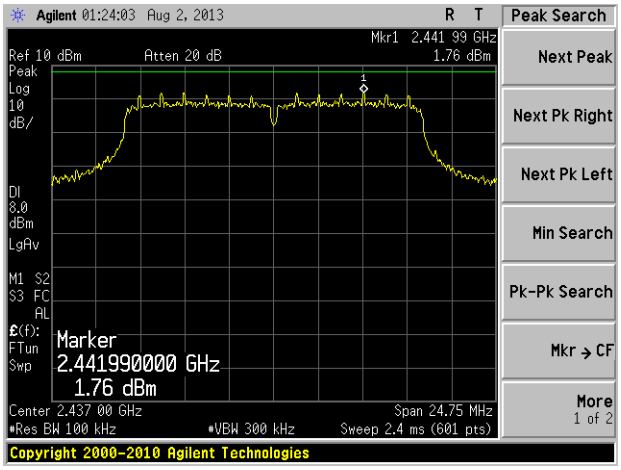


6 MBPS

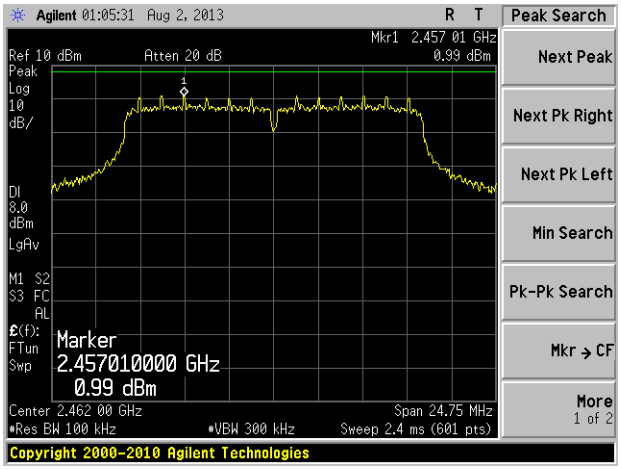
Channel 1



Channel 6

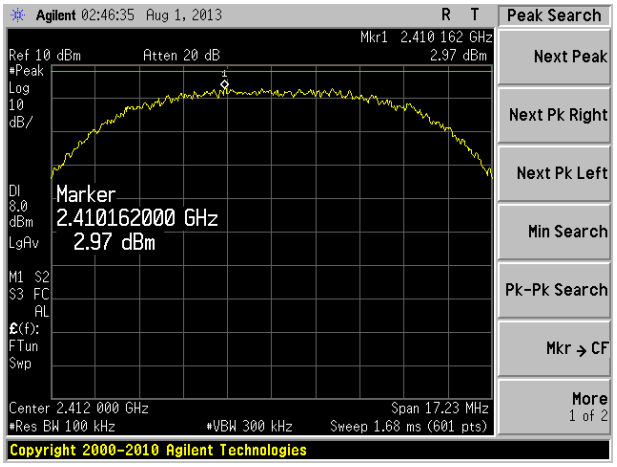


Channel 11

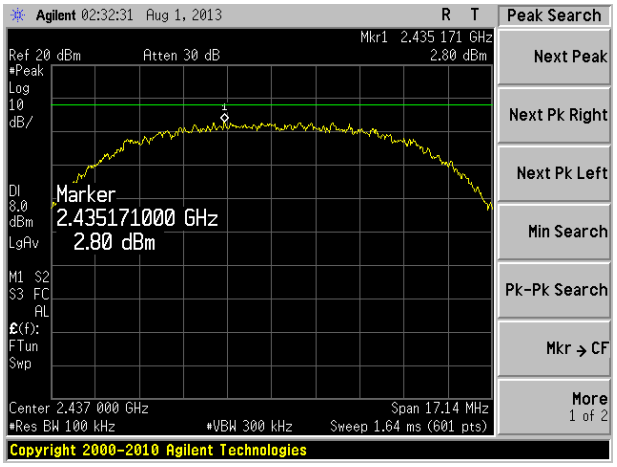


11 MBPS

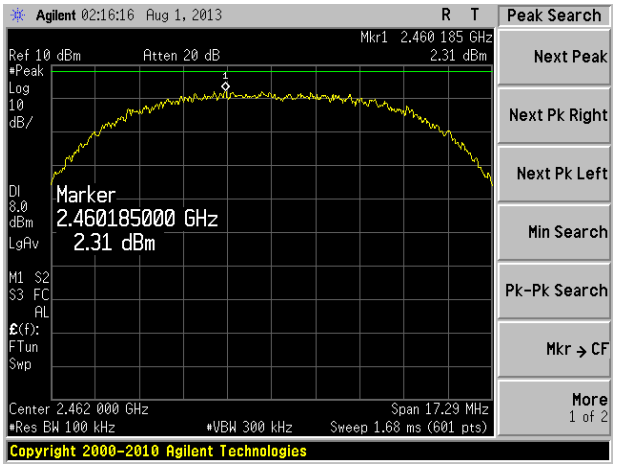
Channel 1



Channel 6

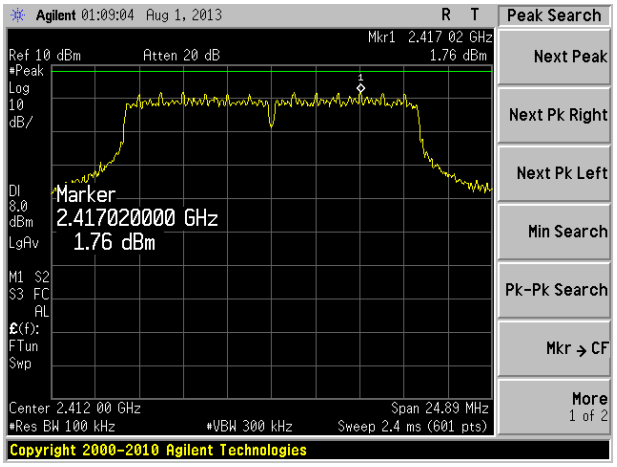


Channel 11

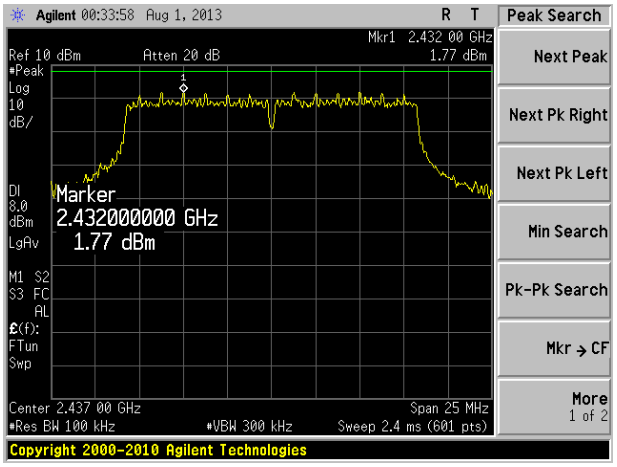


24 MBPS

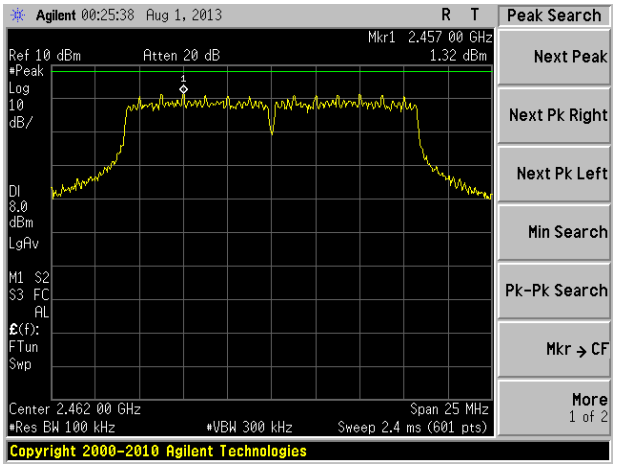
Channel 1



Channel 6

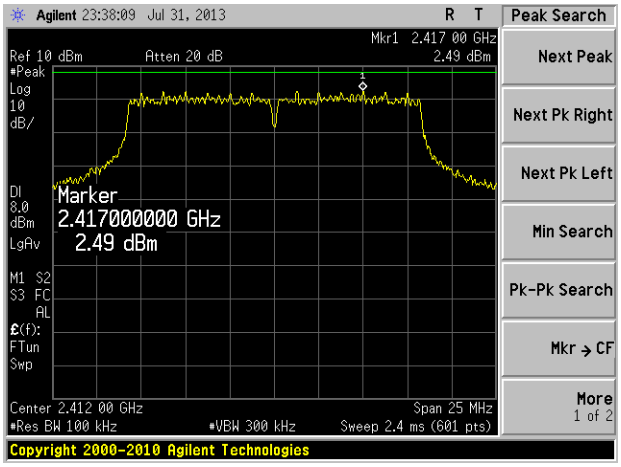


Channel 11

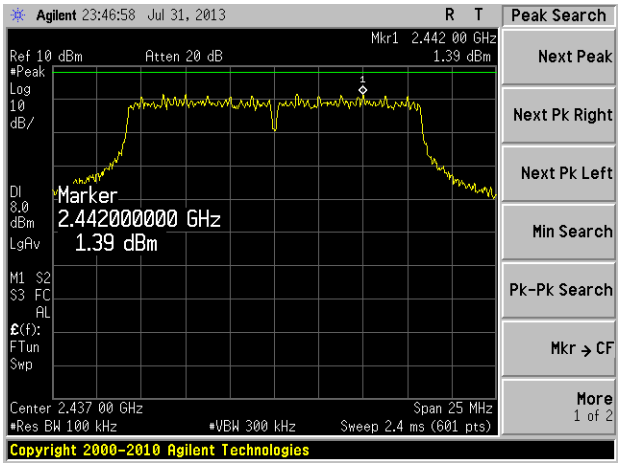


54 MBPS

Channel 1



Channel 6



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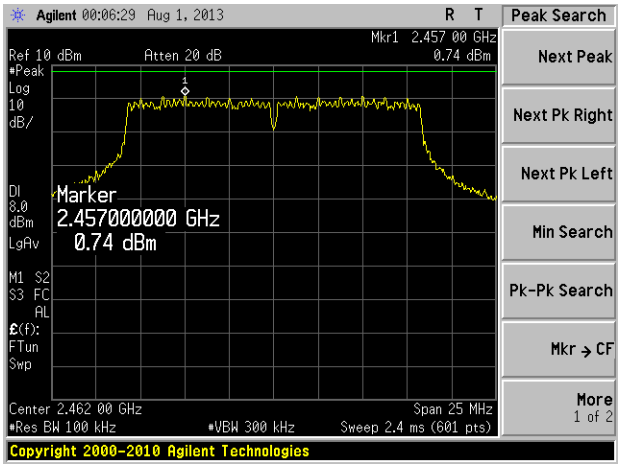
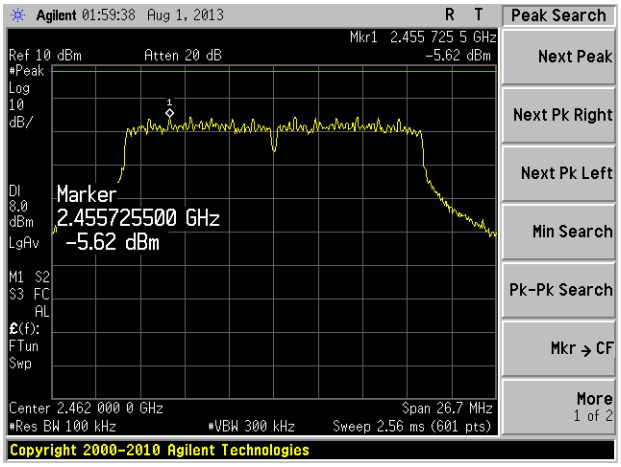
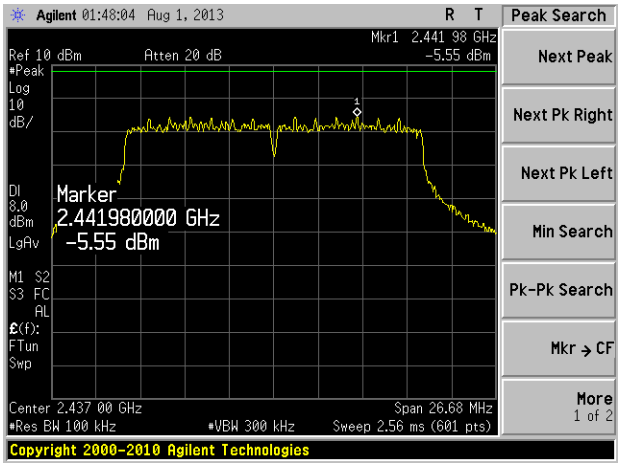


MCS7

Channel 1



Channel 6



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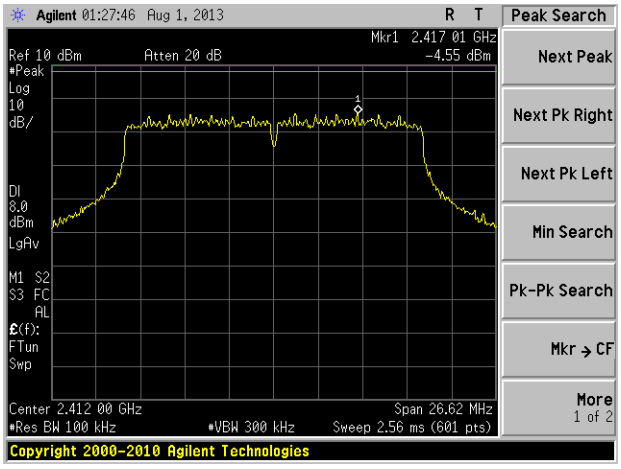
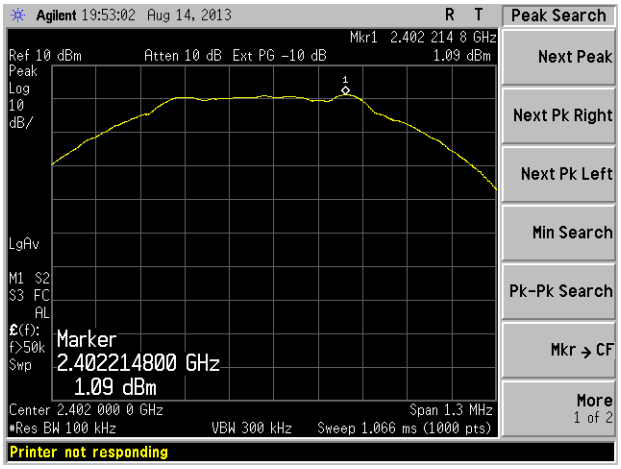
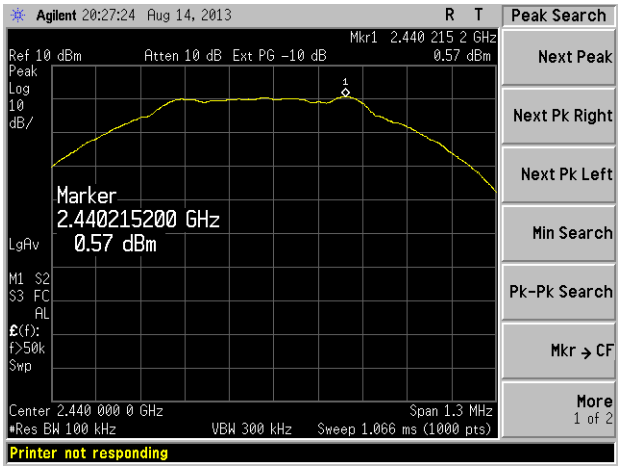


BLE

Channel 0



Channel 19



Channel 39

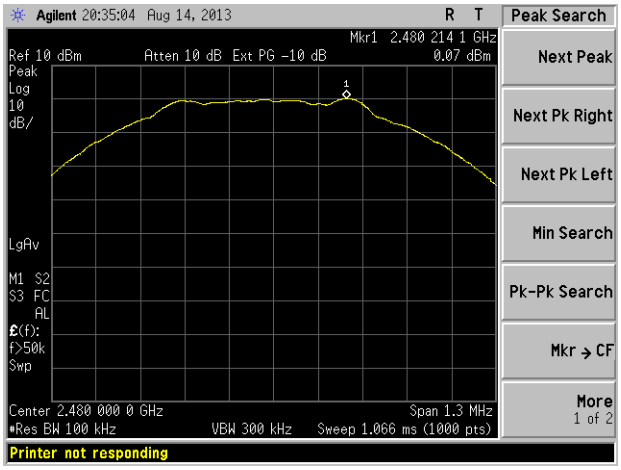


EXHIBIT 10. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

10.1 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) and IC RSS 210 A8.5 requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

10.2 Test Equipment List

Please see Appendix A

10.3 Results

No significant emissions could be noted within -50 dBc of the fundamental level for this product.

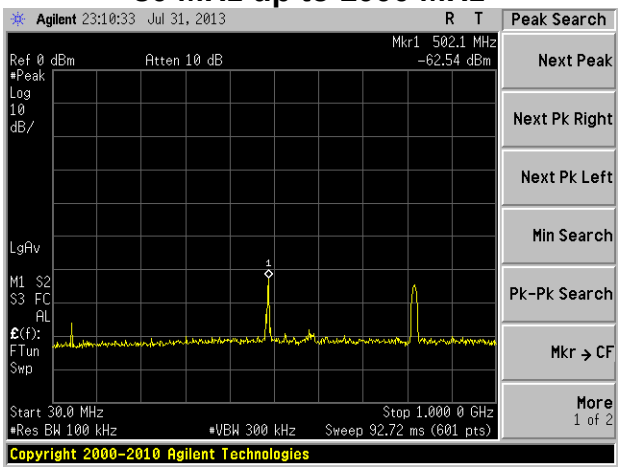
10.4 Test Data

Freq\Chan	1\2412	6\2437	11\2462
fo	3.9	4.0	3.4
2fo	-54.5	-53.4	-55.4
3fo	-71.3	-73.2	-72.7
4fo	Noise Floor	Noise Floor	Noise Floor
5fo	Noise Floor	Noise Floor	Noise Floor
6fo	Noise Floor	Noise Floor	Noise Floor
7fo	Noise Floor	Noise Floor	Noise Floor
8fo	Noise Floor	Noise Floor	Noise Floor
9fo	Noise Floor	Noise Floor	Noise Floor
10fo	Noise Floor	Noise Floor	Noise Floor

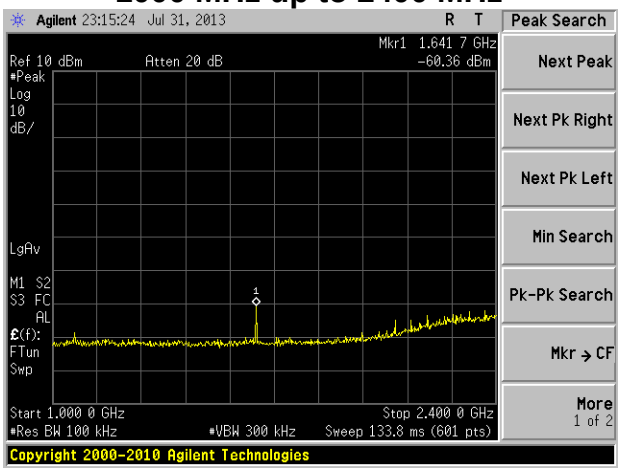
Freq(MHz)	Chan	level(dBm)
502.1	11	-62.54
820.60	11	-64.46
1641.70	11	-60.36
1609.00	1	-60.63
3210.00	1	-64.92
2397.70	1	-33.99

10.3 Screen Captures – Spurious Radiated Emissions

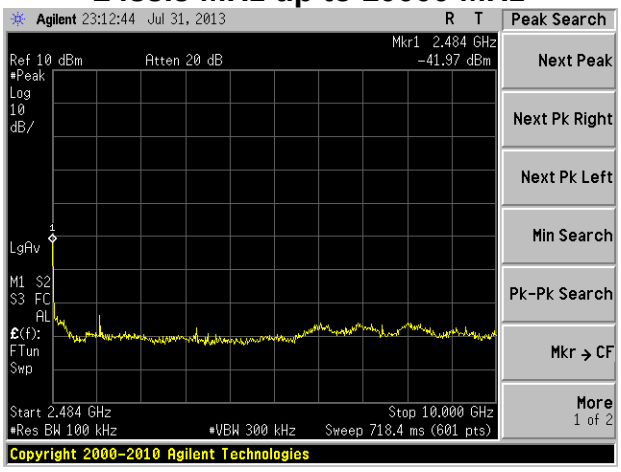
30 MHz up to 1000 MHz



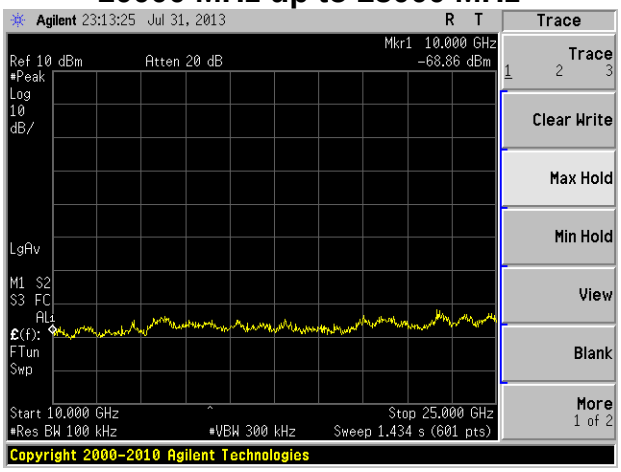
1000 MHz up to 2400 MHz



2483.5 MHz up to 10000 MHz



10000 MHz up to 25000 MHz



APPENDIX A

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 22-Jul-2013 Type Test : Radiated Emissions Job # : C-1677

Prepared By: Customer : Whistle Quote #: 313049

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960156	100kHz-1GHz Analog Signal Generator	Agilent	N5181A	MY49060062	6/30/2012	7/30/2013	Active Calibration
2	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/29/2012	7/29/2013	Active Calibration
3	EE 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/29/2012	7/30/2013	Active Calibration
4	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/29/2013	1/29/2014	Active Calibration
5	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/28/2013	5/28/2014	Active Calibration
6	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	12/12/2012	12/12/2013	Active Calibration
7	AA 960004	Log Periodic Antenna	EMCO	93146	9512-4276	9/17/2012	9/17/2013	Active Calibration
8	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	2/1/2013	2/1/2014	Active Calibration

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 14-Aug-2013 Type Test : Conducted Radio Measurements Job # : C-1677

Prepared By: Customer : Whistle Quote #: 313049

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

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		
CISPR 22	2008-09		
RSS GEN	2010-12		
RSS 210	2010-12		

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*