LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
TESTING CERT #1255.01
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TEST REPORT # 313049-B
LSR Job #: C-1677

Compliance Testing of:
Whistle Dog Monitor

Test Date(s):
July 19, August 8-15, 2013

Prepared For:
Attn: Kevin Lloyd
Whistle Labs
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
Frequency Hopping Spread Spectrum (FHSS) Operating in the Frequency Band 2400-2483.5 MHz

This Test Report is issued under the Authority of: Peter Feilen, EMC Engineer

Signature: Date:

Test Report Reviewed by: Adam Alger, EMC Engineer	Tested by: Peter Feilen, EMC Engineer
Signature: Date: 8-27-13	Signature: Date: 8-21-13

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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.
Environmental Classification:	Commercial, Industrial or Business Residential

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.
FCC Public Notice DA 00-705	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

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 the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

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 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, Suite 211, 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

Custom designed PIFA antenna.

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

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2402-2480 MHz
Maximum Conducted Output Power (in dBm)	GFSK: 2.9 dBm EDR2: 2.7 dBm EDR3: 2.6 dBm
Minimum Conducted Output Power (in dBm)	GFSK: 1.9 dBm EDR2: 1.7 dBm EDR3: 1.6 dBm
Maximum RF Power in Watts	GFSK: 0.0019 EDR2: 0.0019 EDR3: 0.0018
Minimum RF Power in Watts	GFSK: 0.0015 EDR2: 0.0015 EDR3: 0.0014
Occupied Bandwidth (99% BW) (kHz)	GFSK: 873 kHz EDR2: 1226 kHz EDR3: 1227 kHz
Type of Modulation	BT Classic: GFSK EDR: DPSK
Emission Designator	GFSK: 873kFXD EDR2: 1M23FXD EDR3: 1M23FXD
Transmitter Spurious (worst case) at 3 meters	52.7 dBuV/m @ 3m
Receiver Spurious (worst case) at 3 meters	42.9 dBuV/m @ 3m
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	CC2564
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Custom design 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

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 contains a TI CC2564 dual-mode Bluetooth (BT) and Bluetooth Low-Energy system-on-integrated-circuit. The data source/sink and command interface for the transceiver is through a 4-wire UART Host Control Interface (HCI).
The transmitter is based on a direct PLL modulation for the FSK-based modulations (BT 2.1 and BLE 4.0 signaling) and uses Polar modulation techniques for the higher EDR rates which employ differential phase-shift keying modulation. The receiver uses a near-zero IF architecture. Both transmit and receive local oscillators are generated at two-times the carrier frequency and divided by two. A bandpass filter is included on the path between the CC2654 RF signal and the antenna terminal.

The device was programmed through a PC, with USB interface and utilizing TeraTerm software for programming, using commands issued by the device manufacturer specific to the CC2564 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)(1)(i) IC : RSS 210 A8.1 (a)	20 dB Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(d), 15.209 & 15.205 IC : RSS 210 A8.5, section 2.2	Transmitter Radiated Emissions	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(1)(i) IC: RSS 210 A8.1(b)	Carrier Frequency Separation	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 A8.1(d)	Number of hopping channels	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 A8.1(d)	Time of occupancy (Dwell Time)	Yes

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, Section Annex 8 (section A8.1) for a Frequency Hopping Spread Spectrum (FHSS) Transmitter.

Note: 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 C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous modulated transmit mode for final testing using power as provided by a device battery. 3 separate units were provided for testing on 3 different 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 (2402 MHz), middle (2440 MHz) and high (2480 MHz) to comply with FCC Part 15.31(m). The channels and operating modes were controlled with a laptop pc for programming the test unit.

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 10000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Bi-conical 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. A standard gain antenna and preamp were used to make measurements from 18-25 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

5.3 - Test Equipment Utilized

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, Annex 8 for a FHSS 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 2402 to 2480 MHz band, as specified in Title 47 CFR 15.247 and RSS 210 is 1 Watt.

The following table depicts the general radiated emission limits. 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	-
960-24,000	500	54.0	63.5

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

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

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

5.6 - Radiated Emissions Test Data Chart

Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	Whistle Labs					
Date(s) of Test:	July 19, August 8-15, 2013					
Project Engineer:	Peter Feilen					
Voltage:	3 VDC					
Operation Mode:	Continuous, transmit, modulated mode					
Environmental Conditions in the Lab:	Temperature: 20 ˚C Relative Humidity: 38 %					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
	X	Battery		Other: Bench DC Supply		
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

Note:
1. Horiz = Horizontal, Vert = Vertical.

RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of significant radiated harmonic emissions seen on Channel Low:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4804	1.14	210	50.9	45.6	63.5	17.9	Vertical	Vertical
12010	1.09	64	59.4	52.2	63.5	11.3	Horizontal	Vertical
19216	1.00	204	56.8	46.0	63.5	17.5	Horizontal	Side

The following table depicts the level of significant radiated harmonic emissions seen on Channel Middle:

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	1.02	202	54.3	49.8	63.5	13.7	Vertical	Vertical
7320	1.24	100	64.0	61.2	63.5	2.3	Horizontal	Side
12200	1.00	171	63.3	56.6	63.5	6.9	Horizontal	Vertical
19520	1.00	207	55.7	44.7	63.5	18.8	Horizontal	Side

The following table depicts the level of significant radiated harmonic emissions seen on Channel High:

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	203	56.7	53.1	63.5	10.4	Vertical	Vertical
7440	1.24	115	64.9	62.2	63.5	1.3	Horizontal	Side
12400	1.00	131	63.7	57.1	63.5	6.4	Horizontal	Vertical
19840	1.00	190	53.4	42.1	63.5	21.4	Horizontal	Side

Notes:

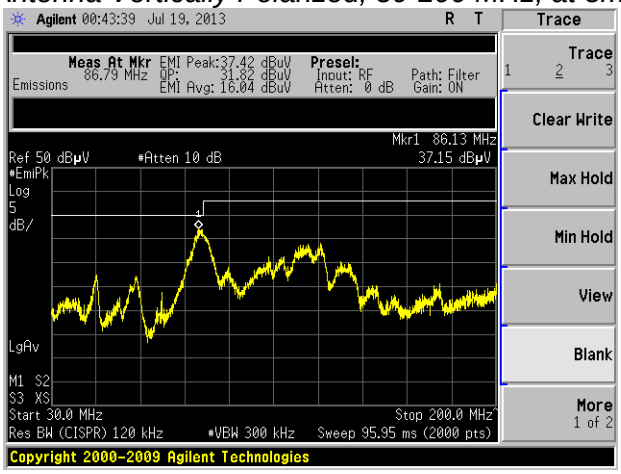
1. To ensure the peak emissions did not exceed 20 dB above the limits a peak detector was used. A peak detector with video averaging was used for measurements above 1 GHz. For average measurements a peak detector with a 10Hz video bandwidth was utilized.
2. Measurements above 4 GHz were made at 1 meters of separation from the EUT. Limits have been corrected to reflect the change in measurement distance.

5.7 - Screen Captures - Radiated Emissions Test

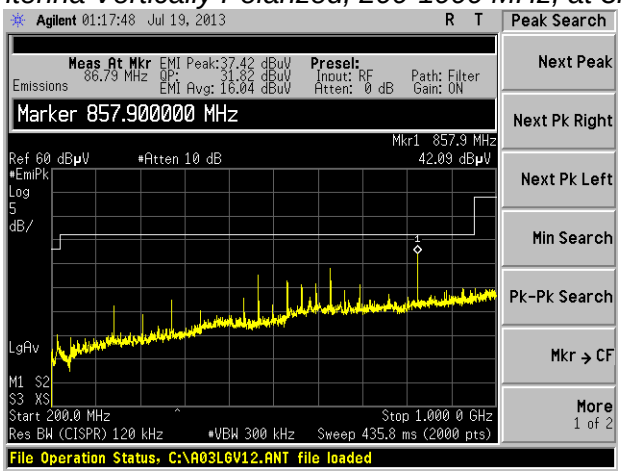
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and a video averaged Peak detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 2402 MHz, 2440 MHz, or 2480 MHz, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

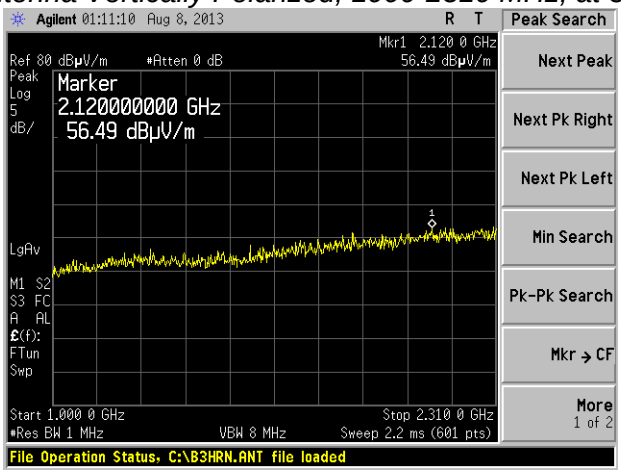
Antenna Vertically Polarized, 30-200 MHz, at 3m



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

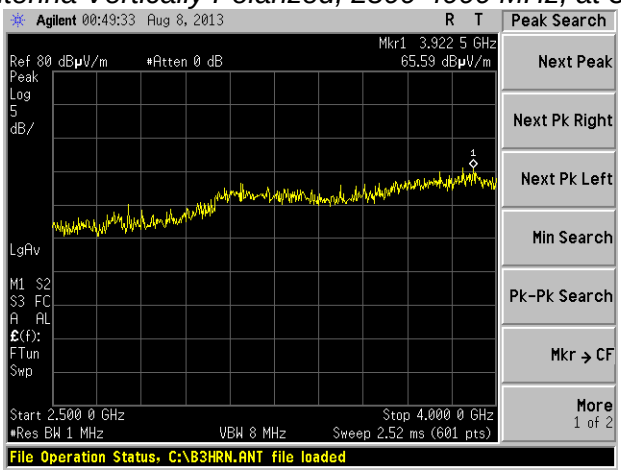


Antenna Vertically Polarized, 1000-2310 MHz, at 3m

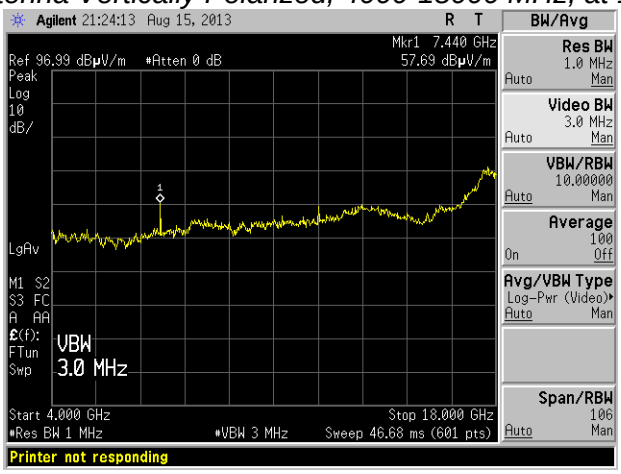


Note: The frequency range 2310-2390 MHz and 2483.5-2500 MHz is in the Band-edge section (Exhibit 8).

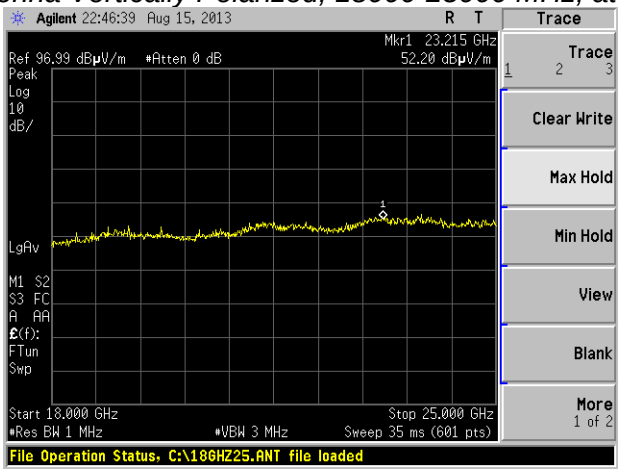
Antenna Vertically Polarized, 2500-4000 MHz, at 3m



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 and CFR 47 part 15, 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 and CFR 47 15.109.

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

Frequency (GHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
9605.0	1.13	100	57.1	52.4	63.5	11.1	HORIZ	SIDE
4802.0	1.14	155	48.4	42.7	63.5	20.8	VERT	SIDE
9757.5	1.07	156	55.3	51.1	63.5	12.4	HORIZ	SIDE
4878.8	1.09	162	50.8	45.4	63.5	18.1	VERT	SIDE
9988.7	1.07	238	53.9	48.8	63.5	14.7	HORIZ	SIDE
4995.4	1.07	155	51.4	45.0	63.5	18.5	VERT	SIDE

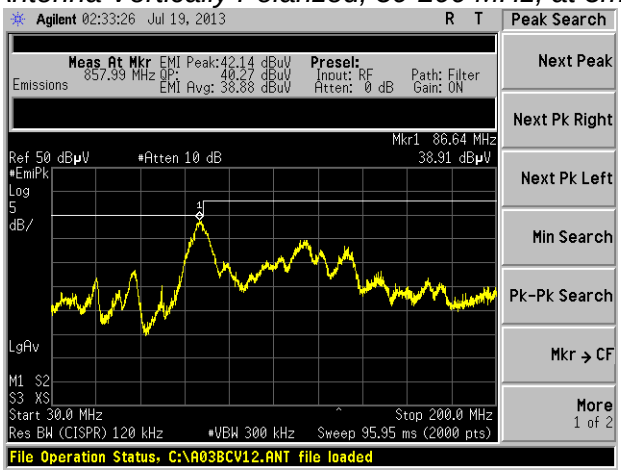
Notes:
1. To ensure the peak emissions did not exceed 20 dB above the limits a peak detector was used. A peak detector with video averaging was used for measurements above 1 GHz. For average measurements a peak detector with a 10Hz video bandwidth was utilized.
2. Measurements above 4 GHz were made at 1 meters of separation from the EUT.

5.10 - Screen Captures - Radiated Emissions Testing – Receive Mode

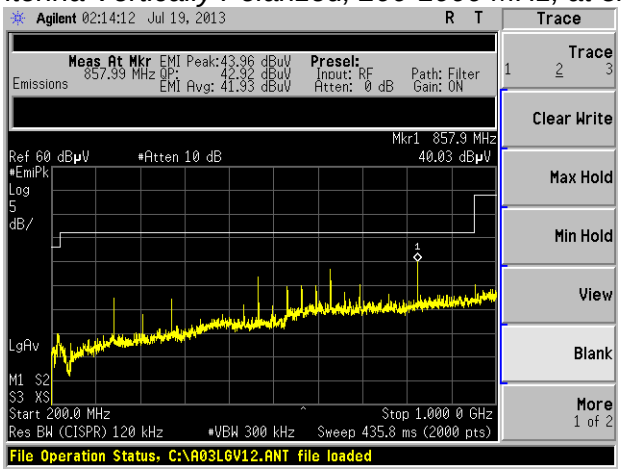
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and a video averaged Peak detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 2402 MHz, 2440 MHz, or 2480 MHz, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

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

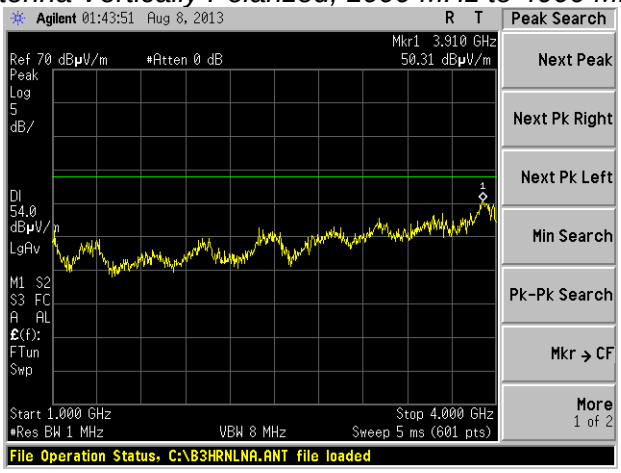


Antenna Vertically Polarized, 200-1000 MHz, at 3m

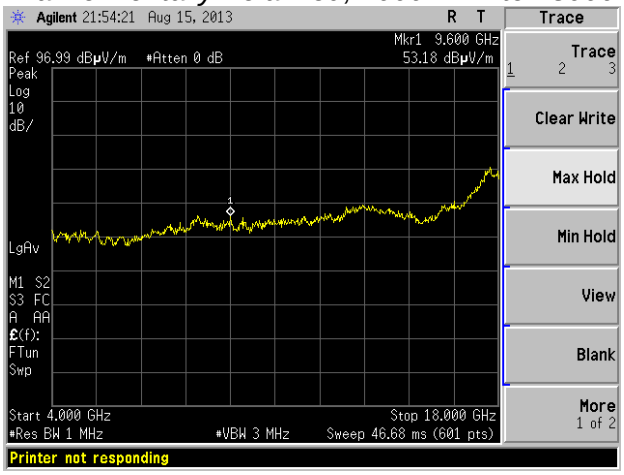


Screen Captures - Radiated Emissions Testing – Receive Mode (continued)

Antenna Vertically Polarized, 1000 MHz to 4000 MHz



Antenna Horizontally Polarized, 4000 MHz to 18000MHz



Antenna Horizontally Polarized, 18000 MHz to 25000MHz

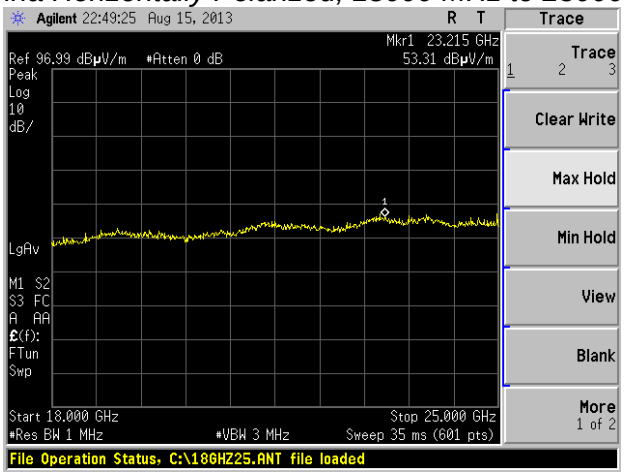


EXHIBIT 6. OCCUPIED BANDWIDTH

6.1 - Method of Measurements

The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 10 kHz RBW and VBW=100 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 a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the attenuator was added on the analyzer as gain offset settings, allowing direct measurements, without the need for any further corrections. 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.

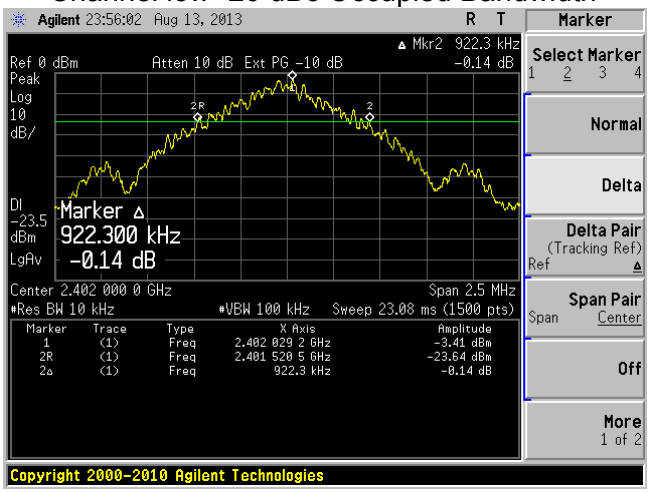
6.2 - Test Data

Mode	Channel	Frequency (MHz)	20 dB BW (kHz)	99 % BW (kHz)
GFSK	Low	2402	922.3	866.9
	Mid	2440	922.3	871.2
	High	2480	923.9	872.8
EDR2	Low	2402	1384.3	1225.7
	Mid	2440	1375.9	1223.2
	High	2480	1374.2	1225.2
EDR3	Low	2402	1369.2	1226.5
	Mid	2440	1369.2	1225.8
	High	2480	1370.9	1222.2

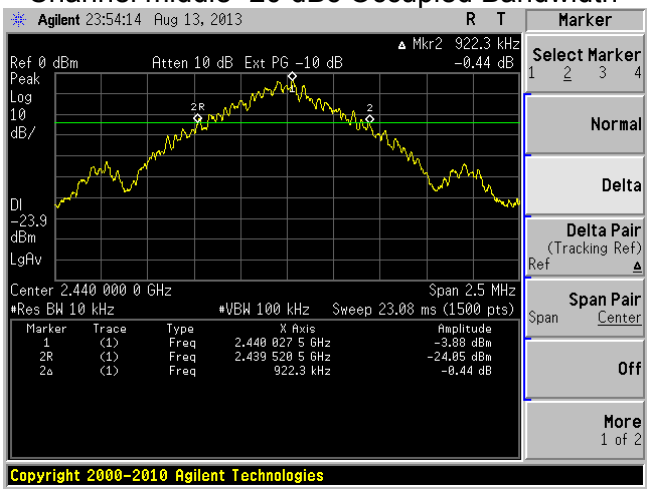
6.3 - Screen Captures - Occupied Bandwidth

GFSK Mode

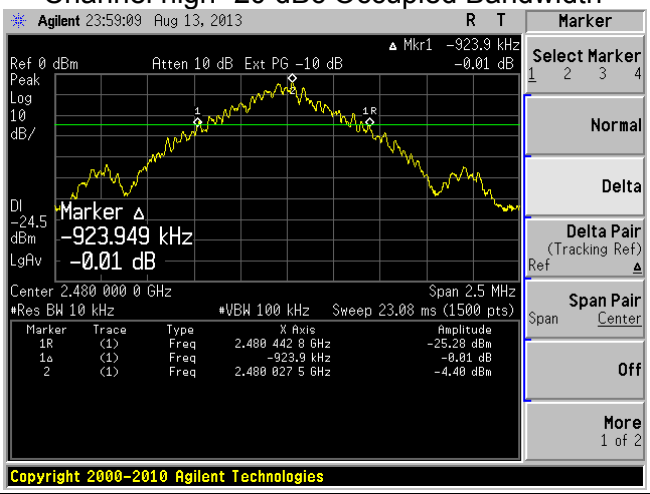
Channel low -20 dBc Occupied Bandwidth



Channel middle -20 dBc Occupied Bandwidth

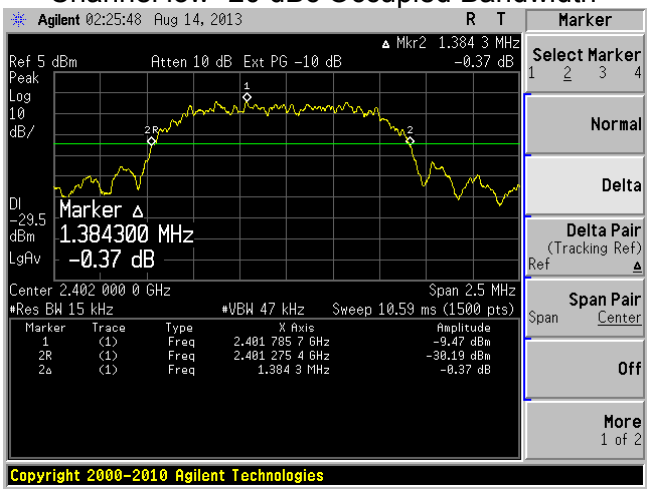


Channel high -20 dBc Occupied Bandwidth

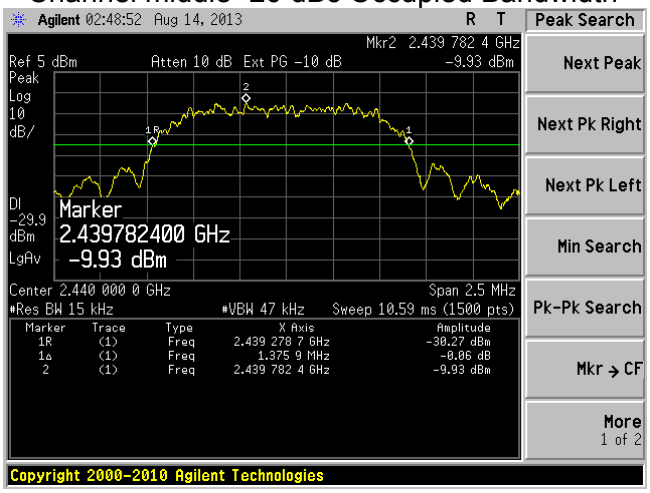


EDR2 Mode

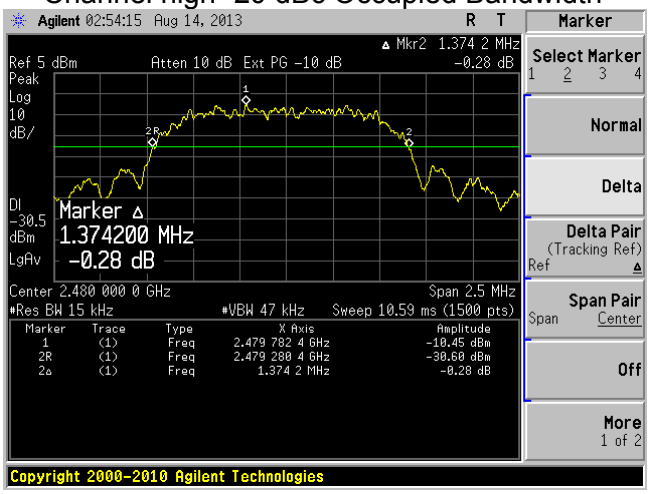
Channel low -20 dBc Occupied Bandwidth



Channel middle -20 dBc Occupied Bandwidth

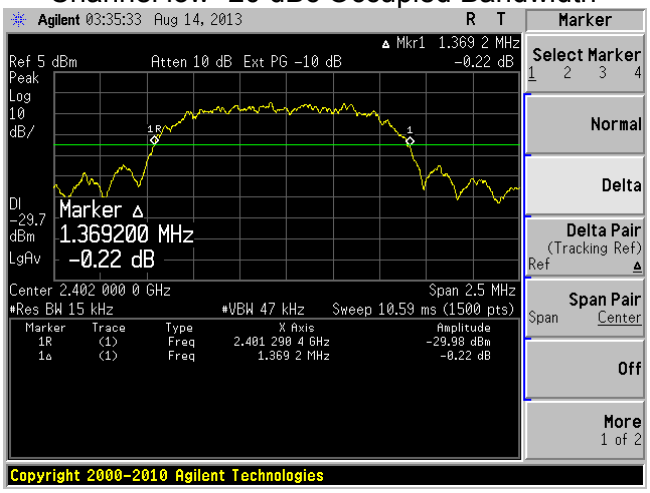


Channel high -20 dBc Occupied Bandwidth

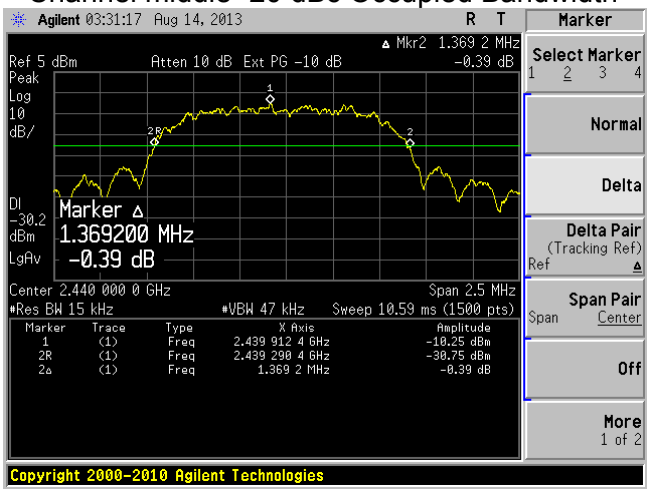


EDR3 Mode

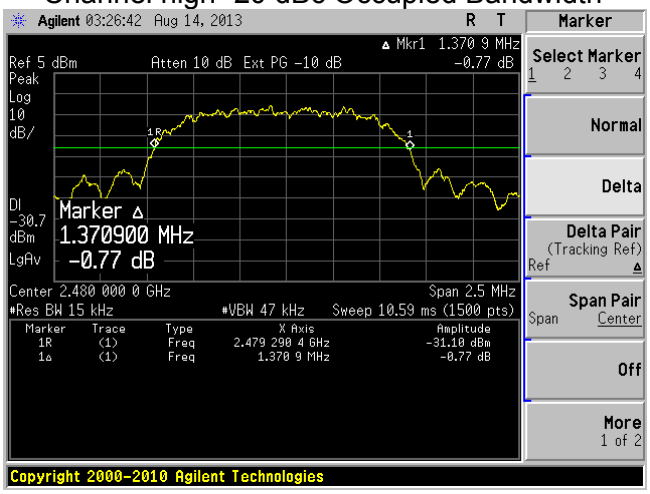
Channel low -20 dBc Occupied Bandwidth



Channel middle -20 dBc Occupied Bandwidth

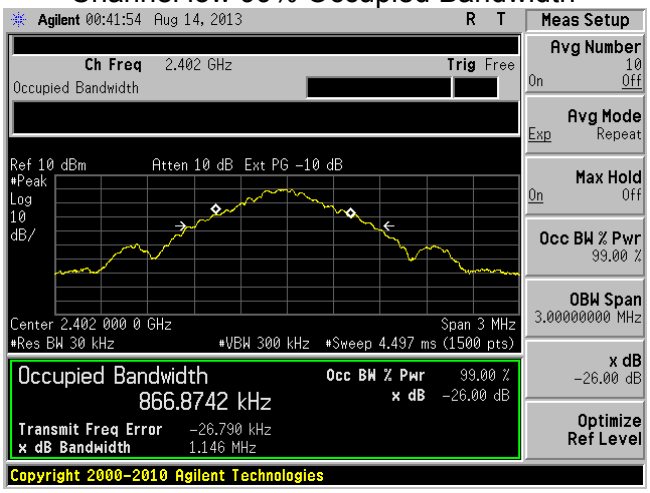


Channel high -20 dBc Occupied Bandwidth

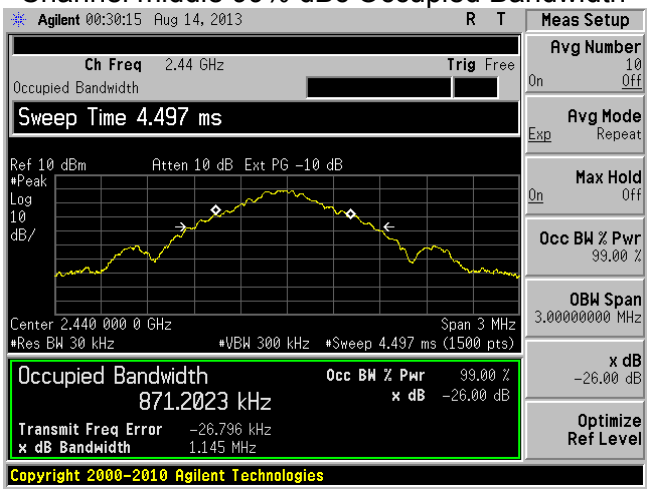


GFSK Mode

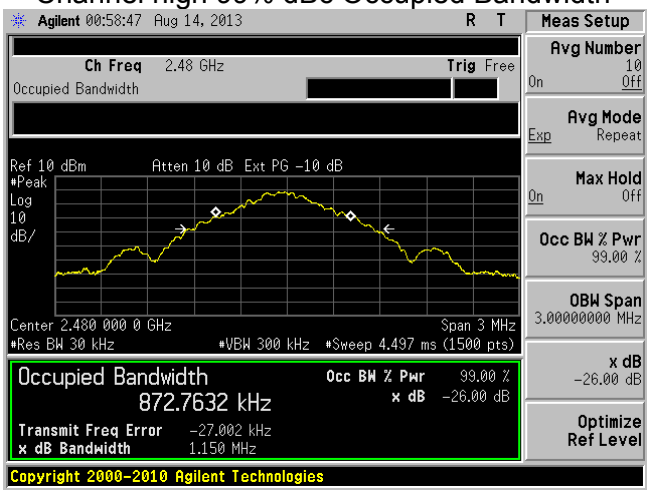
Channel low 99% Occupied Bandwidth



Channel middle 99% dBc Occupied Bandwidth

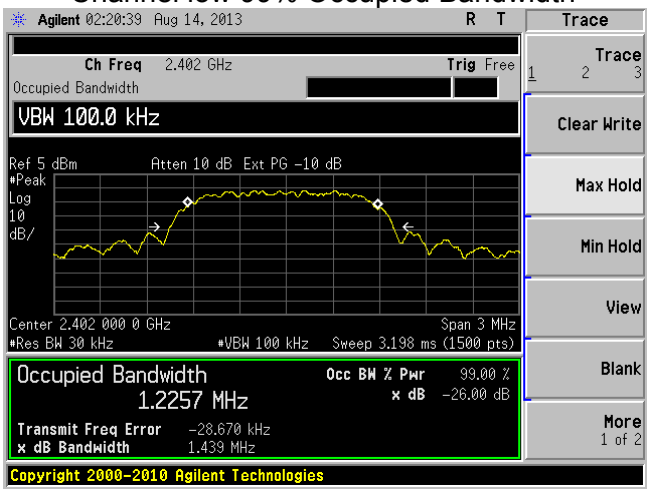


Channel high 99% dBc Occupied Bandwidth

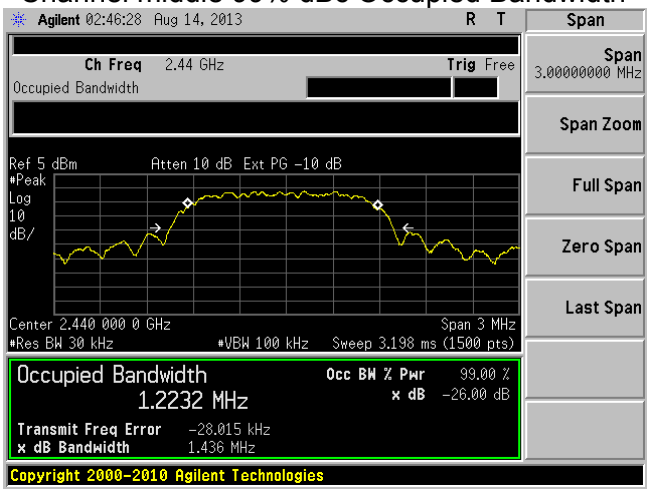


EDR2 Mode

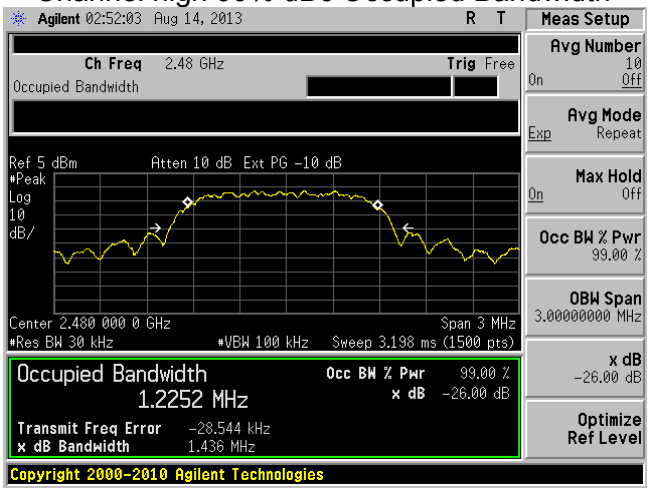
Channel low 99% Occupied Bandwidth



Channel middle 99% dBc Occupied Bandwidth

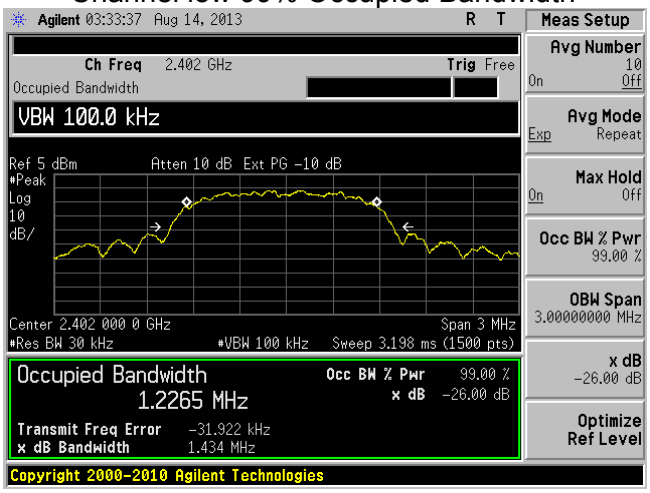


Channel high 99% dBc Occupied Bandwidth

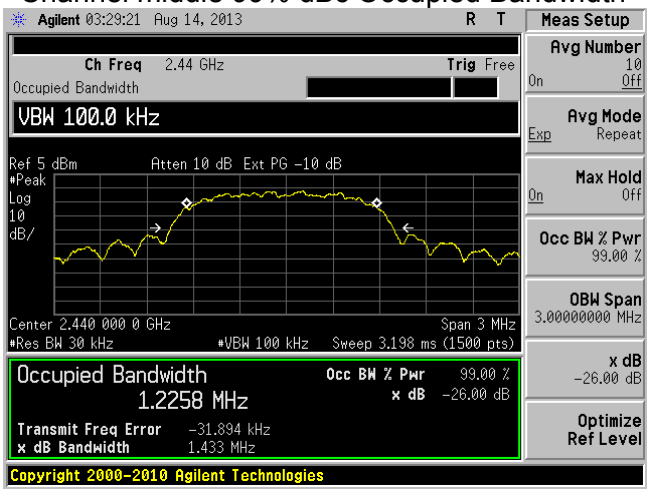


EDR3 Mode

Channel low 99% Occupied Bandwidth



Channel middle 99% dBc Occupied Bandwidth



Channel high 99% dBc Occupied Bandwidth

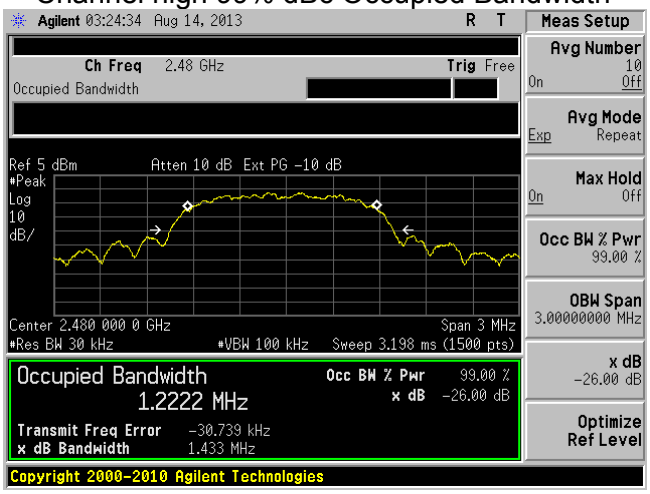


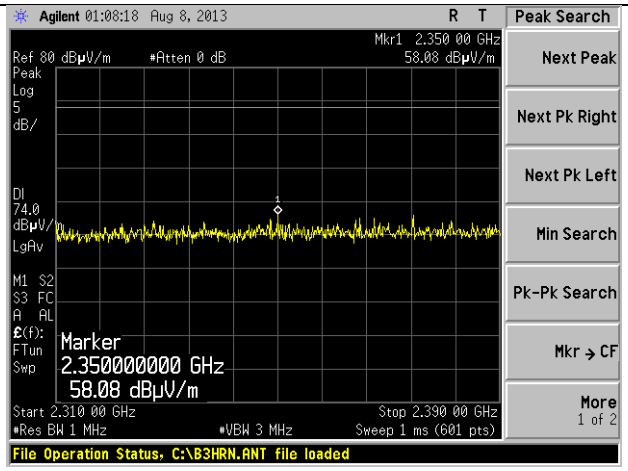
EXHIBIT 7. BAND EDGE MEASUREMENTS

7.1 - Method of Measurements

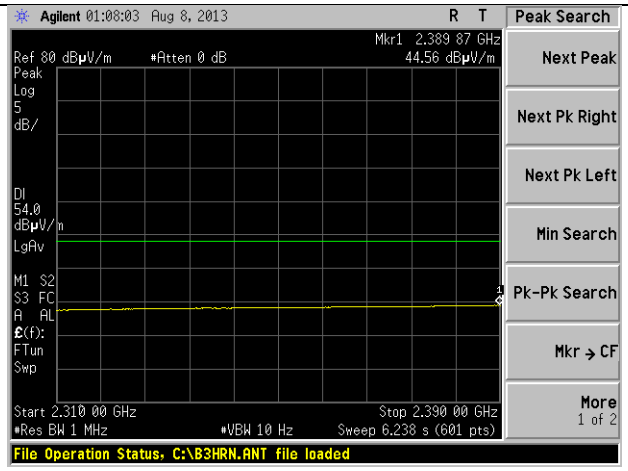
The following screen captures demonstrate compliance of the intentional radiator at the 2402 MHz to 2480 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

Radiated Bandedge

Screen Capture Demonstrating Compliance at the Lower Band-Edge

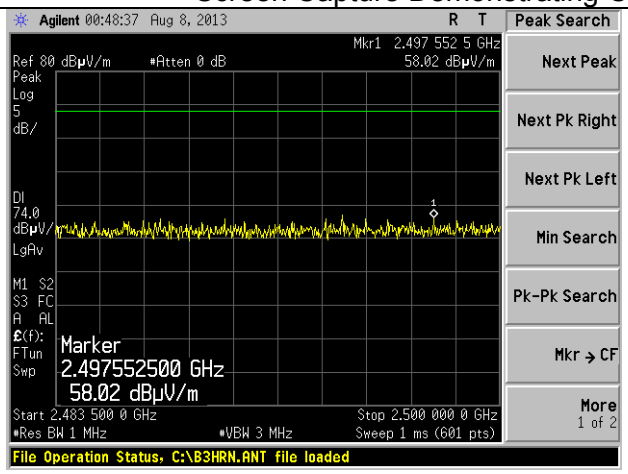


PEAK

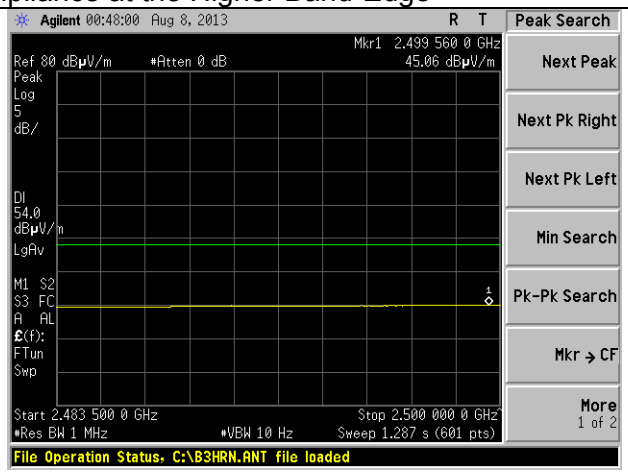


AVERAGE

Screen Capture Demonstrating Compliance at the Higher Band-Edge



PEAK



AVERAGE

Conducted Bandedge

Screen Capture Demonstrating Compliance at the Lower Band-Edge

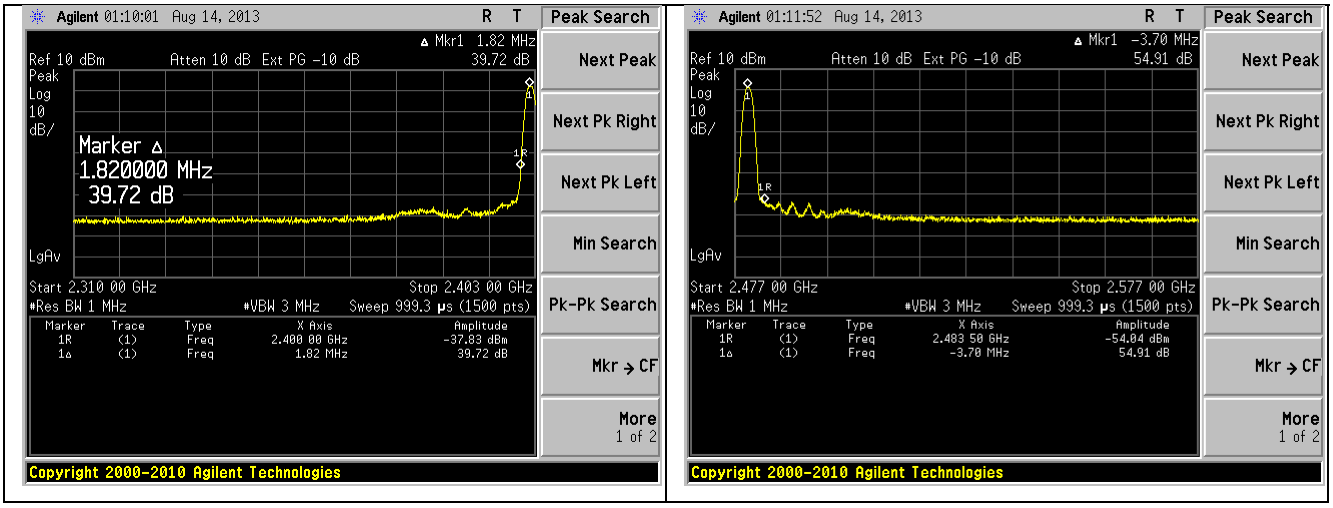


EXHIBIT 8. POWER OUTPUT (CONDUCTED)

8.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the the attenuator was added on the analyzer as gain offset setting. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

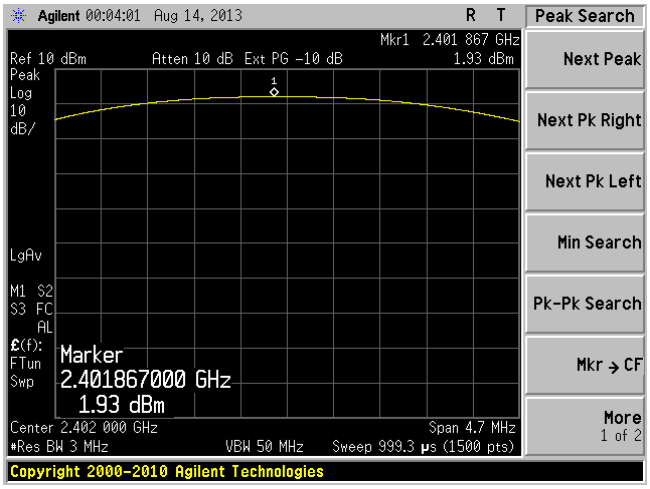
8.2 - Test Data

Mode	Channel	Frequency (MHz)	Measured Power (dBm)	Cable Insertion Loss (dB)	Adjusted Power (dBm)	Limit (dBm)	Margin (dBm)
GFSK	Low	2402	1.9	1.0	2.9	30.0	27.1
	Mid	2440	1.4	1.0	2.4	30.0	27.6
	High	2480	0.9	1.0	1.9	30.0	28.1
EDR2	Low	2402	1.7	1.0	2.7	30.0	27.3
	Mid	2440	1.3	1.0	2.3	30.0	27.8
	High	2480	0.8	1.0	1.8	30.0	28.2
EDR3	Low	2402	1.6	1.0	2.6	30.0	27.4
	Mid	2440	1.1	1.0	2.1	30.0	27.9
	High	2480	0.6	1.0	1.6	30.0	28.4

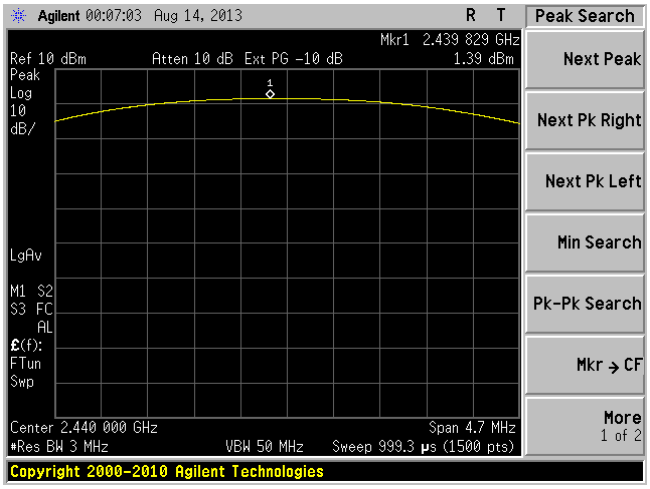
8.3 - Screen Captures – Power Output (Conducted)

GFSK Mode:

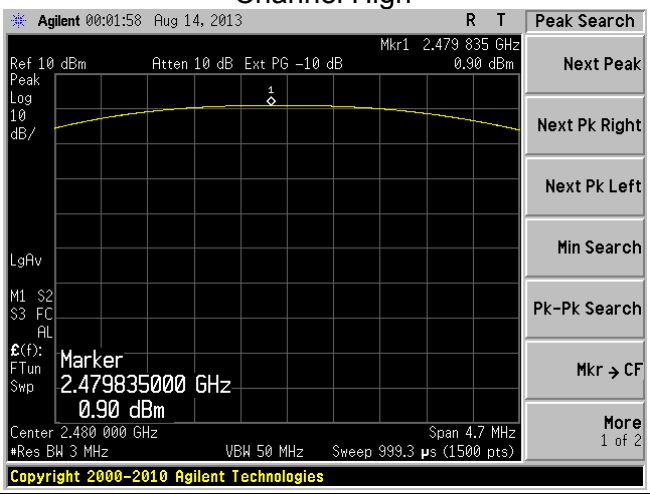
Channel Low



Channel Middle

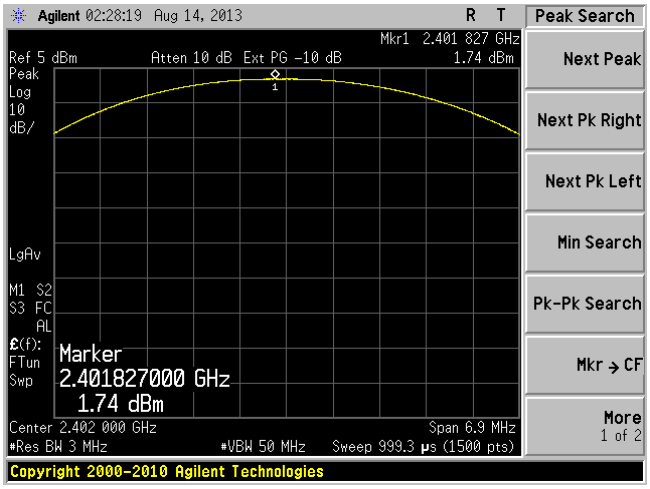


Channel High

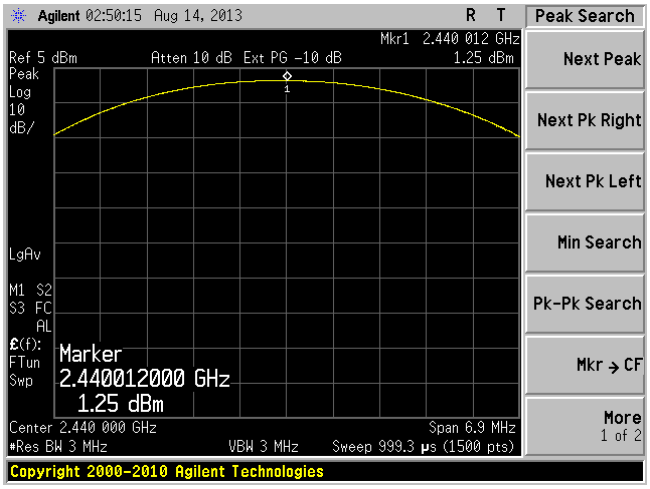


EDR2 Mode:

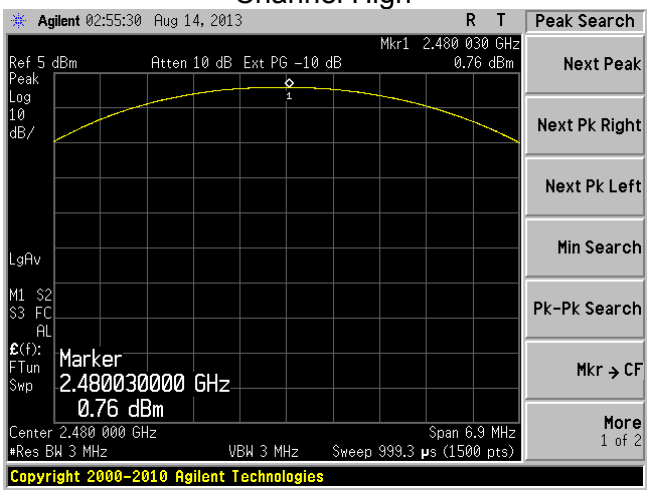
Channel Low



Channel Middle

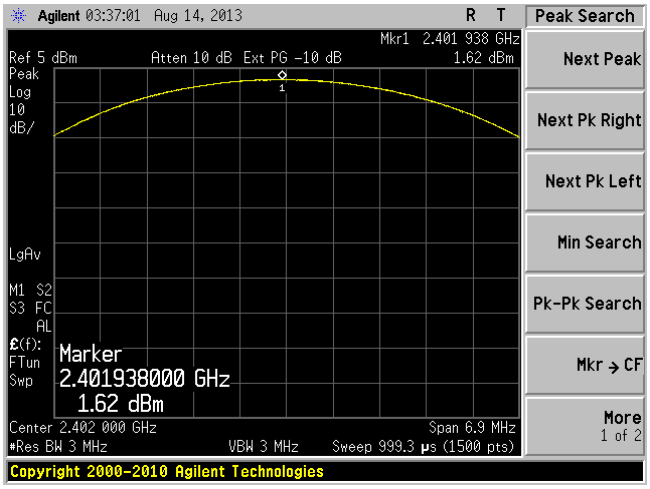


Channel High

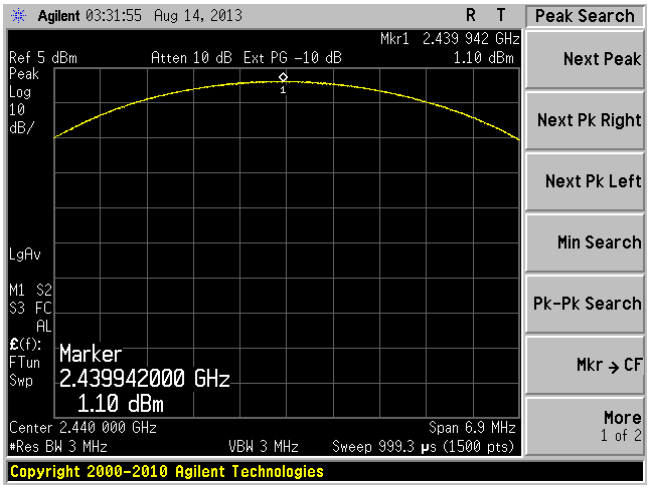


EDR3 Mode:

Channel Low



Channel Middle



Channel High

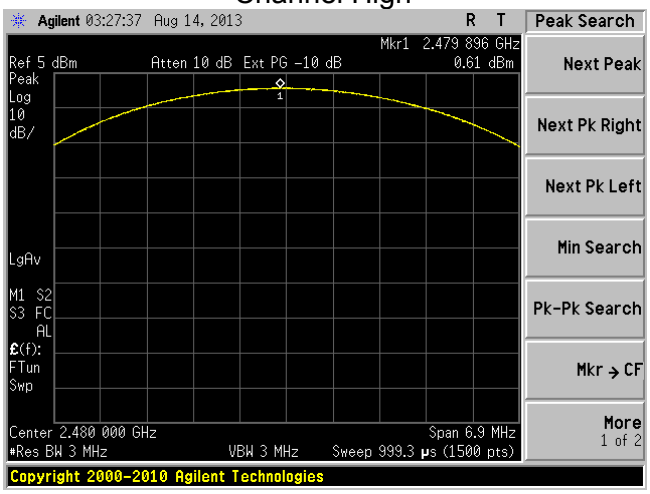


EXHIBIT 9. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

9.1 - 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.

9.2 – Conducted Harmonic And Spurious RF Measurements

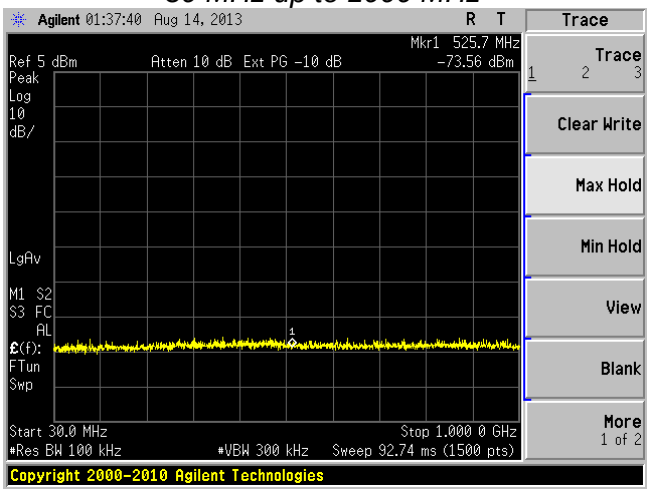
FCC Part 15.247(d) and IC RSS 210 A8.5 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

Conducted Spurious Data

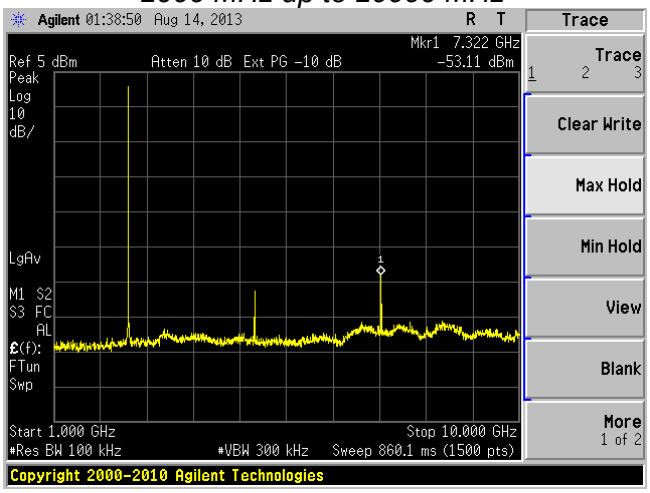
Freq\Chan	0\2402	19\2440	39\2480
fo	2.1	1.9	1.3
2fo	-52.6	-57.2	-57.3
3fo	-50.7	-50.7	-51.8
4fo	Noise Floor	Noise Floor	Noise Floor
5fo	Noise Floor	Noise Floor	Noise Floor
6fo	Noise Floor	Noise Floor	Noise Floor
7fo	Noise Floor	Noise Floor	Noise Floor
8fo	Noise Floor	Noise Floor	Noise Floor
9fo	Noise Floor	Noise Floor	Noise Floor
10fo	Noise Floor	Noise Floor	Noise Floor

9.3 - Screen Captures – Spurious Conducted Emissions

30 MHz up to 1000 MHz



1000 MHz up to 10000 MHz



10000 MHz up to 26000 MHz

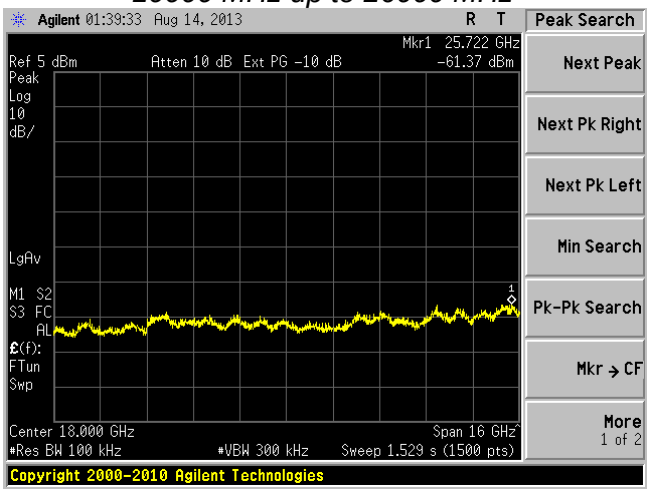


EXHIBIT 10. CHANNEL PLAN AND SEPARATION

A spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT. Plots of all channels are provided with a 300 kHz resolution bandwidth.

The minimum and maximum channel-separations measured for this device are 967.7 kHz and 1004 kHz respectively.

The minimum channel separation limit as stated in FCC CFR 47 15.247 and IC RSS210 is 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided power is 125 mW or below, which this device qualifies for.

The minimum number of channels limit as stated in FCC CFR 47 15.247 and IC RSS210 is 15 channels.

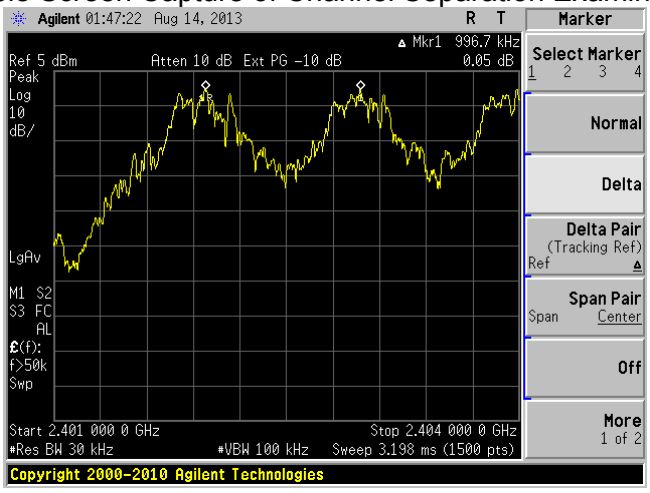
The following plots describe this spacing, and also establish the channel separation and plan.

RANGE (MHz)	NUMBER OF CHANNELS PER CAPTURE	Max separation (Hz)
2400 -2419.5	18	1000
2419.5 – 2439.5	20	1002
2439.5 – 2459.5	20	1000
2459.5 – 2483.5	21	1004

Total Channels	79
Max separation	1002
Min Separation	996.7

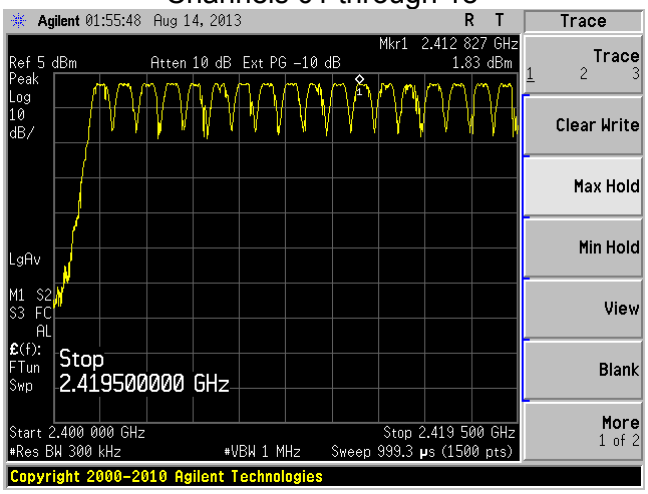
Total number of channels = 79

Sample Screen Capture of Channel Separation Examination

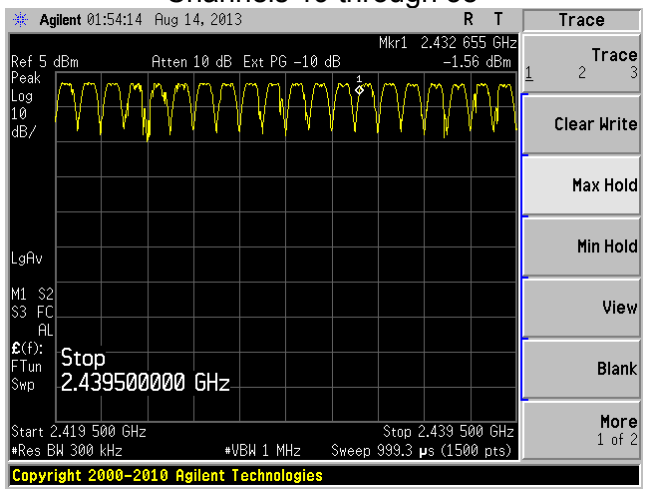


10.1 - Screen Captures – Channel Separation

Channels 01 through 18

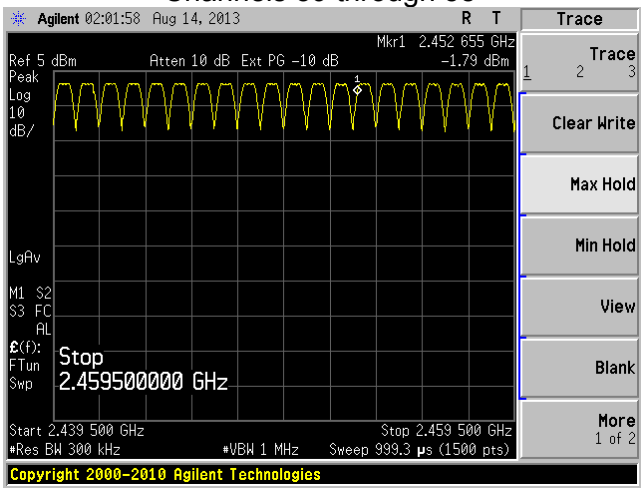


Channels 19 through 38



Screen Captures – Channel Separation *(continued)*

Channels 39 through 58



Channels 59 through 79

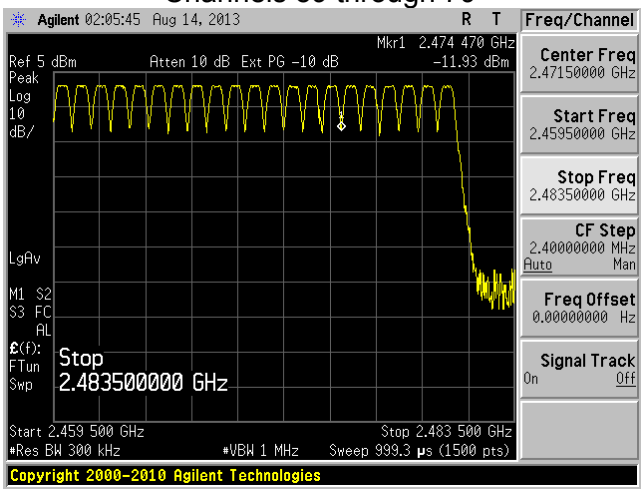


EXHIBIT 11. CHANNEL OCCUPANCY

Part 15.247(a)(1) requires a channel occupancy of no more than 400 milliseconds in a 31.6 second window for this device, based on 79 hop channels. The channel occupancy for this EUT was measured using a spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths can be measured by adjusting the sweep rate of the analyzer. A suitable sweep rate was used to measure the channel occupancy at the low, mid and high channels.

The longest time any transmission will occur on a single channel is 2.9 milliseconds. In a 10 second window, each channel has 32 transmissions. The maximum occupancy in a 31.6 second window is calculated by multiplying 32 transmissions/10-second window by 3.16 10-second windows by 2.908 milliseconds, to arrive at 294 milliseconds total occupancy.

GFSK

Channel	Frequency (MHz)	Occupancy in 5 ms window (ms)	Total Occupancy in 10 seconds (ms)
Low	2402	2.903	92.9
Middle	2440	2.908	93.0
High	2480	2.908	93.0

EDR2

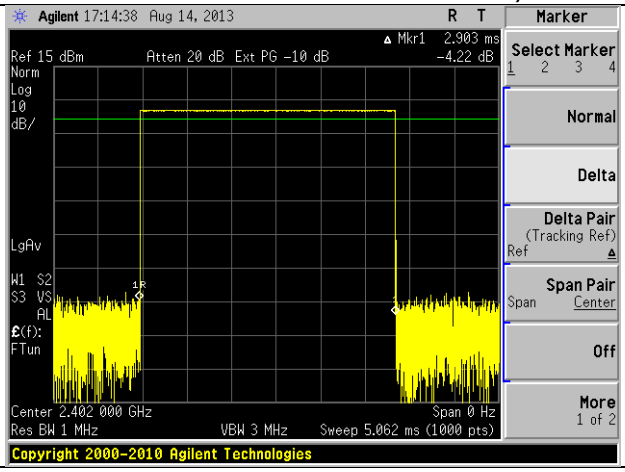
Channel	Frequency (MHz)	Occupancy in 5 ms window (ms)	Total Occupancy in 10 seconds (ms)
Low	2402	1.581	50.6
Middle	2440	1.576	50.4
High	2480	1.571	50.3

EDR3

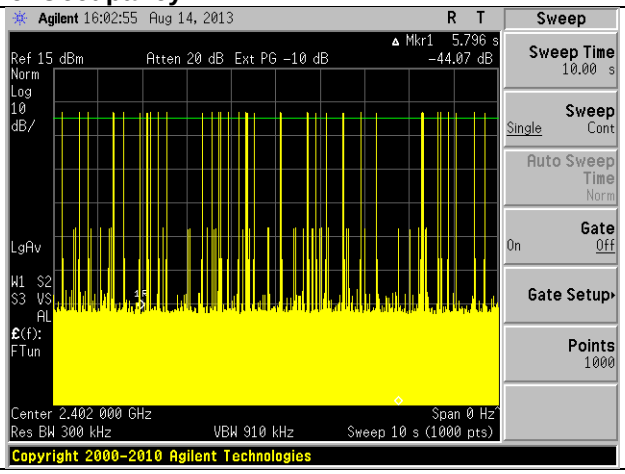
Channel	Frequency (MHz)	Occupancy in 5 ms window (ms)	Total Occupancy in 10 seconds (ms)
Low	2402	1.115	32.3
Middle	2440	1.115	32.3
High	2480	1.115	32.3

Plots of Channel Occupancy

GFSK, Low Channel Occupancy

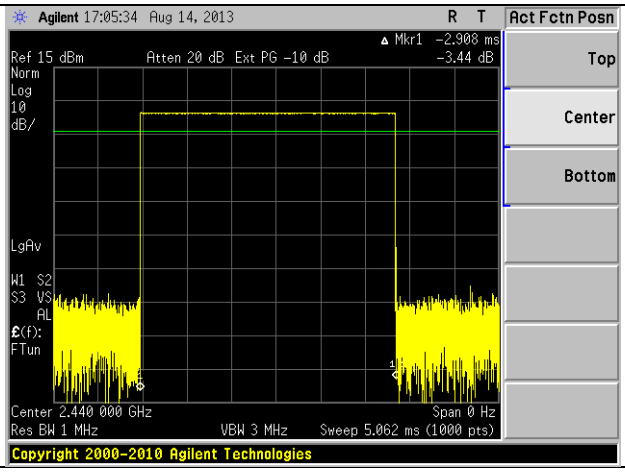


5 ms window

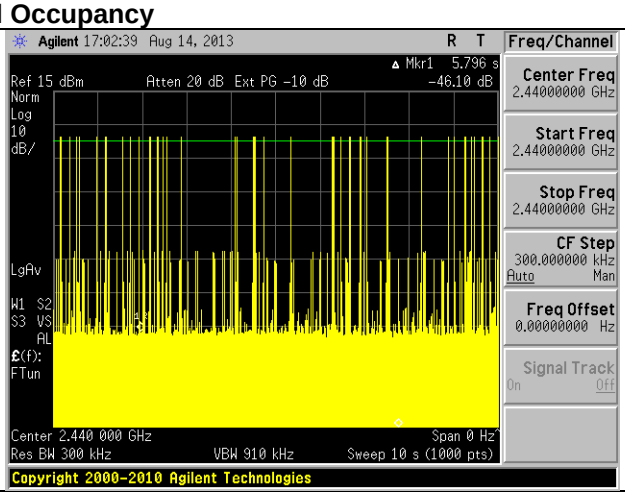


10 seconds window

Middle Channel Occupancy

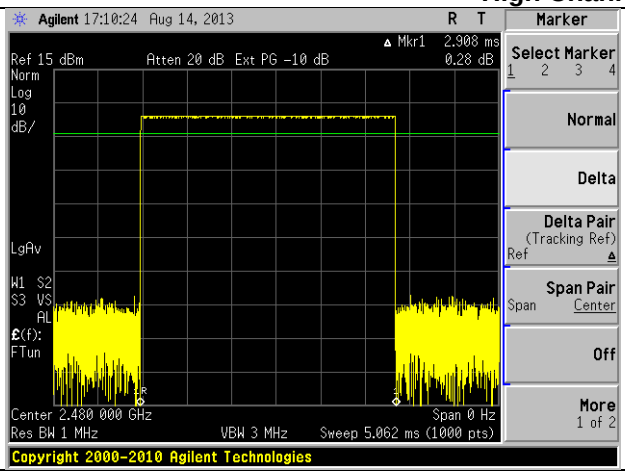


5 ms window

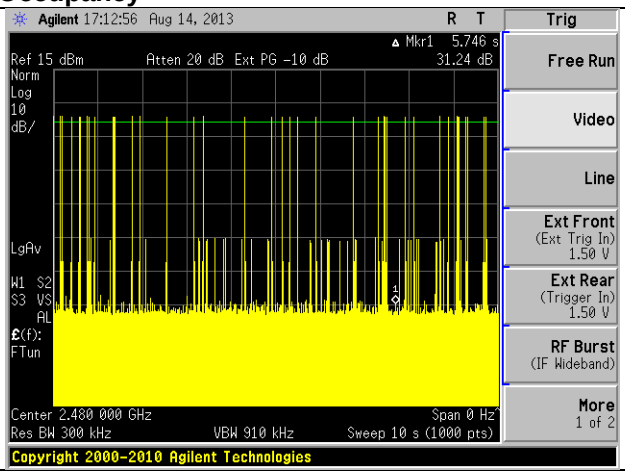


10 seconds window

High Channel Occupancy



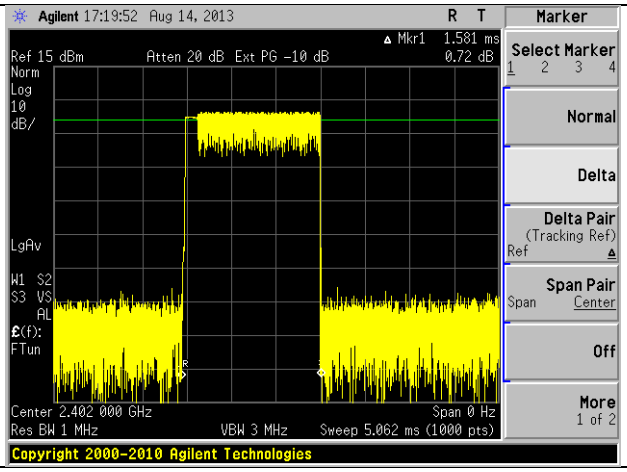
5 ms window



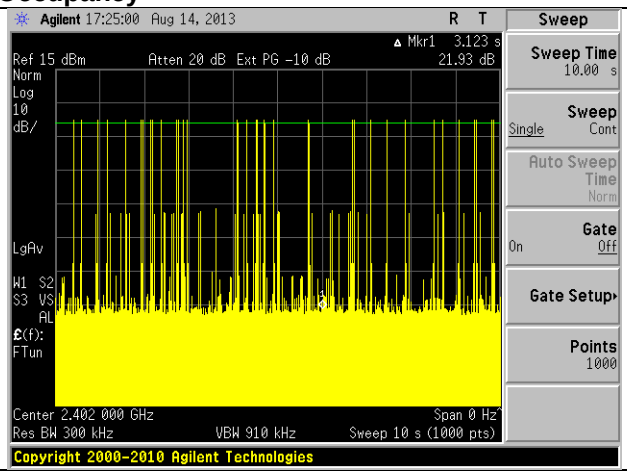
10 seconds window

EDR2

Low Channel Occupancy

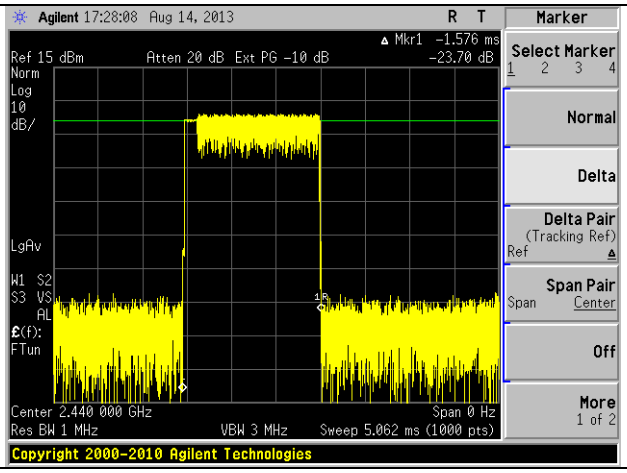


5 ms window

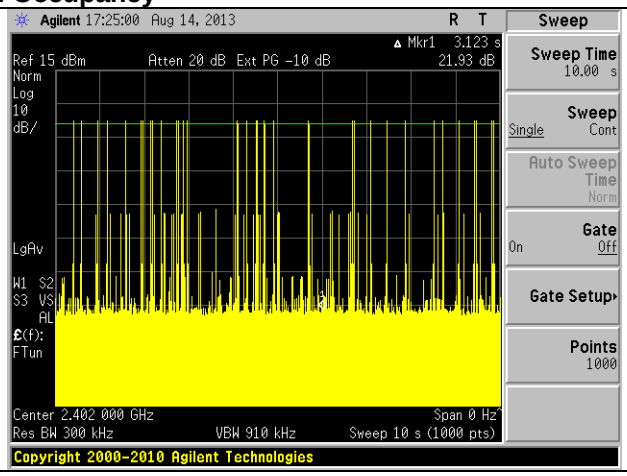


10 seconds window

Middle Channel Occupancy

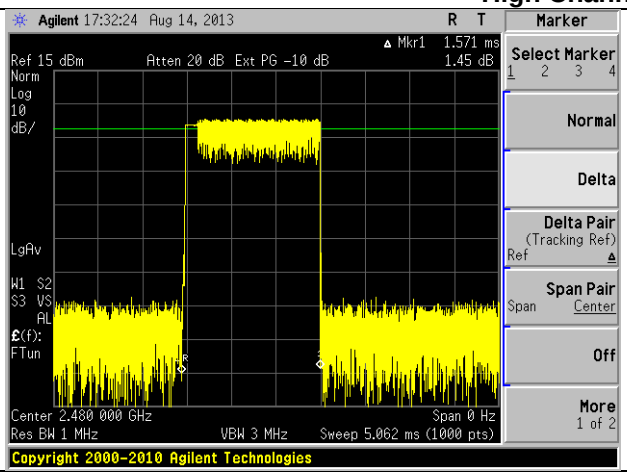


5 ms window

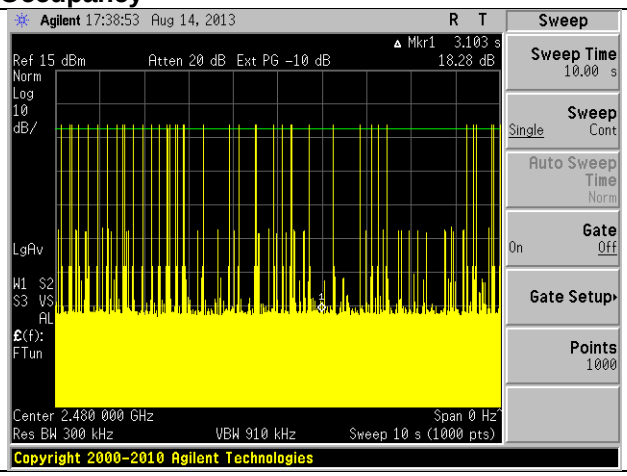


10 seconds window

High Channel Occupancy



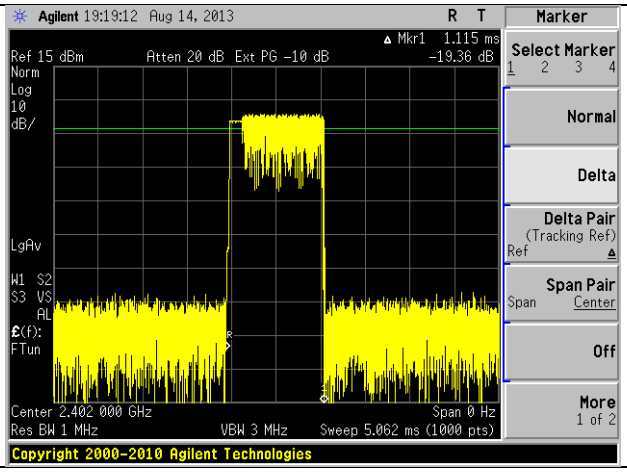
5 ms window



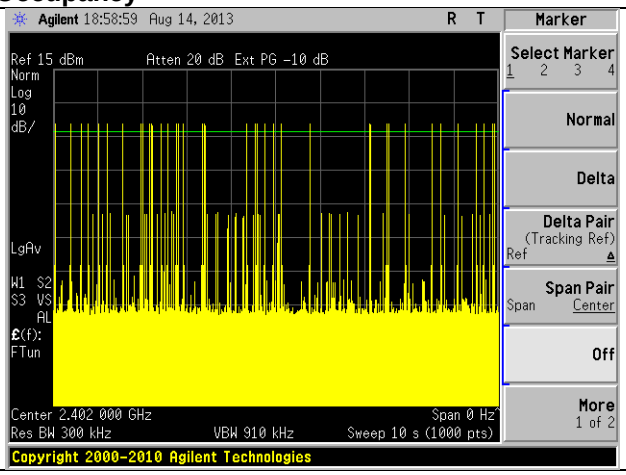
10 seconds window

EDR3

Low Channel Occupancy

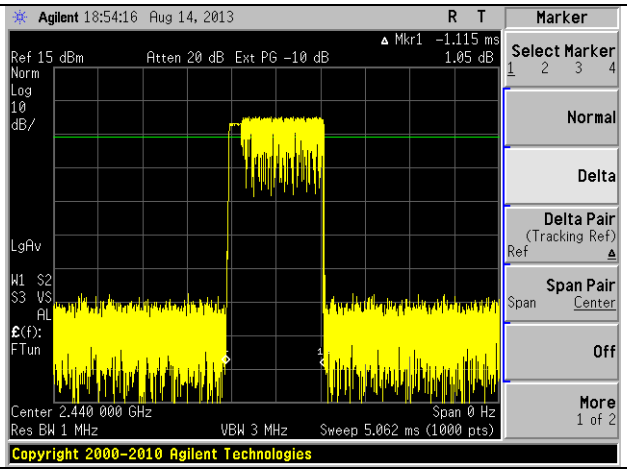


5 ms window

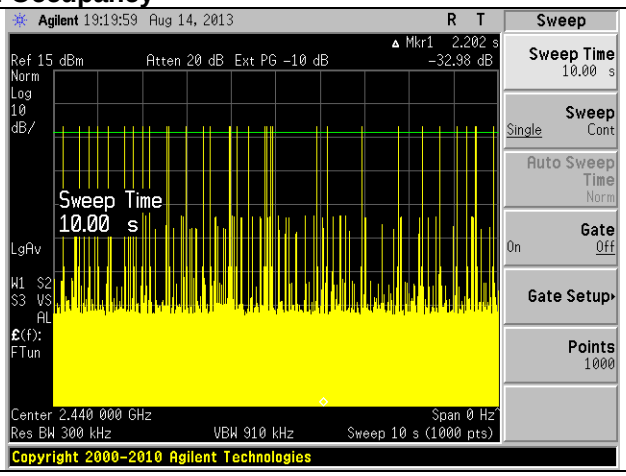


10 seconds window

Middle Channel Occupancy

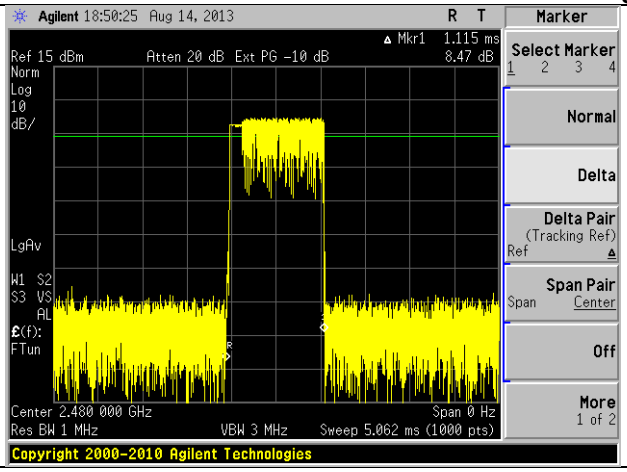


5 ms window

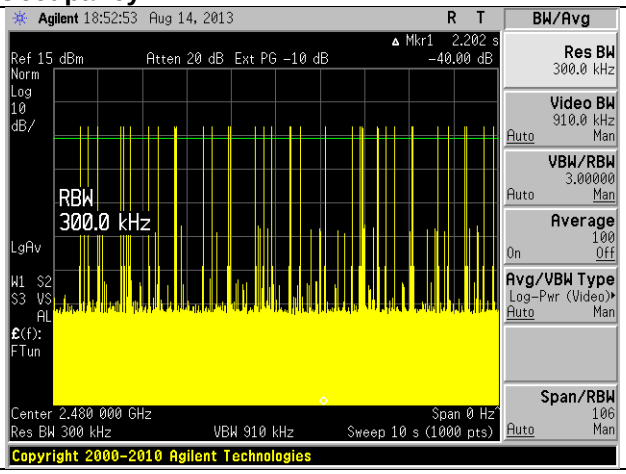


10 seconds window

Channel High Occupancy



5 ms window



10 seconds window

EXHIBIT 12. EQUAL CHANNEL USAGE AND PSEUDORANDOM HOPPING SEQUENCE.

By virtue of following the Bluetooth standard, the CC2564 chipset ensures equal channel usage and pseudorandom hopping sequence is met.

The following information is provided from the customer:

Bluetooth devices shall use the hopping kernel as defined in the following sections.

In total, six types of hopping sequence are defined ☐ five for the basic hop system and one for an adapted set of hop locations used by adaptive frequency hopping (AFH). These sequences are:

• A **page hopping sequence** with 32 wake-up frequencies distributed equally over the 79 MHz, with a period length of 32;
• A **page response hopping sequence** covering 32 response frequencies that are in a one-to-one correspondence to the current page hopping sequence. The master and slave use different rules to obtain the same sequence;
• An **inquiry hopping sequence** with 32 wake-up frequencies distributed equally over the 79 MHz, with a period length of 32;
• An **inquiry response hopping sequence** covering 32 response frequencies that are in a one-to-one correspondence to the current inquiry hopping sequence.
• A **basic channel hopping sequence** which has a very long period length, which does not show repetitive patterns over a short time interval, and which distributes the hop frequencies equally over the 79 MHz during a short time interval.
• An **adapted channel hopping sequence** derived from the basic channel hopping sequence which uses the same channel mechanism and may use fewer than 79 frequencies. The adapted channel hopping sequence is only used in place of the basic channel hopping sequence. All other hopping sequences are not affected by hop sequence adaptation.

General Selection Scheme

The selection scheme consists of two parts:
• selecting a sequence;
• mapping this sequence onto the hop frequencies

EXHIBIT 13. RECEIVER SYNCHRONIZATION AND RECEIVER INPUT BANDWIDTH.

By virtue of following the Bluetooth standard, receiver synchronization and receiver input bandwidth requirements are met.

Receiver synchronization is accomplished by correlating a 64bit word, breaking each bit to 5 chips (resulting in 320 chips), if more than ~290 chips are correct, sync is received.

APPENDIX A – Test Equipment List

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

Project Engineer: Peter Fielen Quality Assurance: Adam Alger

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
CISPR 22	2008-09		
RSS GEN	2007-06		
RSS 210	2010-08		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2009		
FCC DA-0075	2000		

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*