LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
TESTING CERT #1255.01
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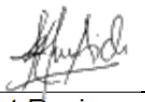
TEST REPORT # TR 312142 A C-1489 FCCIC FHSS
LSR Job #: C-1489

Compliance Testing of:
Logic PD 37x Torpedo + Wireless SOM

Test Date(s):
January 9th to July 10th 2012

Prepared For:
Logic PD
411 Washington Ave N. Suite 400
Minneapolis, MN 55401

This Test Report is issued under the Authority of:
Khairul Aidi Zainal, Senior EMC Engineer

Signature:  Date:7/31/12

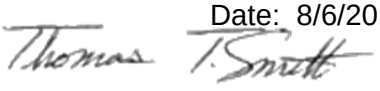
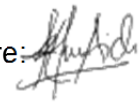
Test Report Reviewed by: Tom Smith	Project Engineer:
Signature:  Date: 8/6/2012	Khairul Aidi Zainal, Senior EMC Engineer.
	Signature:  Date:7/31/12

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1. 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	Year	Title
FCC CFR Parts 0-15	2012	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 3	2010	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB DA 00-705 FHSS Measurement Guidance	2000	Guidance for Performing Compliance Measurements on Frequency Hopping Spread Spectrum Transmission Systems (FHSS) Operating Under §15.247

1.3 - LS Research, LLC Test Facility

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

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. Accreditation status can be verified at A2LA's web site: www.a2la2.net.

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/IEC 17025, and traceable to the SI standard.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Logic PD
Address:	411 Washington Ave N. Suite 4, Minneapolis, MN 55401
Contact Name:	Joe Charboneau

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	37x Torpedo + Wireless SOM
Model Number:	SOMDM3730-30-2780AKCR-B
Serial Number:	2012M00619/2012M01222 (Radiated) 2012M00625/2012M01201 (Radiated) 2411M00976/4511M01290 (Radiated) 4511M01221(Radiated) 2911M00065/4511M01156 (Conducted) 2012M00627/2012M01206 (Conducted) 2012M00626/2012M01208(Conducted)

2.3 - Associated Antenna Description

The antenna associated with the EUT is a dual band isolated Magnetic dipole (IMD) with gains:

1. 2.5dBi peak between 2.39 to 2.49 GHz.
2. 3.5dBi peak between 4.9 to 5.9 GHz.

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2402 MHz to 2480 MHz
Maximum Conducted output power in Watts	0.00167 Watts
Minimum Conducted output power in Watts	0.00103 Watts
Field Strength at 3 meters	Not Applicable
Maximum Conducted output power in dBm	
Occupied Bandwidth (99% BW)	GFSK = 886.5kHz EDR2 = 1.243MHz EDR3 = 1.292MHz
Type of Modulation	FHSS
EIRP (in mW)	N/A
Transmitter Spurious (worst case) at 3 meters	52.96dBµV/m at 4960MHz
Stepped (Y/N)	N/A
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 100 PPM
Transceiver Model # (if applicable)	WL1283 (Texas Instrument)
Microprocessor #	DM3730 (Texas Instrument)
Antenna Information	
Detachable/non-detachable	Detachable
Type	Dual band isolated magnetic dipole.
Gain (in dBi)	2.5dBi peak between 2.39 to 2.49 GHz. 3.5dBi peak between 4.9 to 5.9 GHz.
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?	Mobile

RF Technical Information:

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

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

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
Duty Cycle used in evaluation: 100 %
Standard used for evaluation: OET 65
Measurement Distance: 20 cm
RF Value: **0.00591** ☐ V/m ☐ A/m ☒ W/m^2
☐ Measured ☐ Computed ☒ Calculated

2.5 - Product Description

The 37x Torpedo + wireless SOM is an ultra-compact off-the-shelf solution for applications in markets where network connectivity is required and space is a premium. The product is used by OEM integrators to gain access to 802.11 a/b/g/n, Bluetooth, and GPS capabilities.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70 -71° F
Humidity:	32-42%
Pressure:	728-741mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes
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(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC :15.247(c) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(1)(i) IC: RSS 210 (b)	Carrier Frequency Separation	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 (c),(d),(e)	Number of hopping channels	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 (c),(d),(e)	Time of occupancy (Dwell Time)	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes

3.3 - Modifications Inocorporated 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 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 bench DC supply.

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 (2402MHz), middle (2440MHz) and high (2480MHz) to comply with FCC Part 15.31(m). The channels and operating modes were controlled via laptop PC.

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 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. 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 18-25 GHz, a standard gain horn antenna with preamp was used.

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

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at an IEC/ISO 17025 accredited calibration laboratory, traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an EMI Receiver. 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 resolution bandwidths as prescribed in ANSI C63.4.

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 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

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

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/m).

As specified in 15.247 (d) and RSS 210 A8.5, radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2 of RSS 210 for IC, must comply with the general emissions limit.

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 GEN.

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):
$dB\mu V/m = 20 \log_{10} (100) = 40\ dB\mu V/m$ (from 30-88 MHz)

5.6 - Radiated Emissions Test Data Chart

Manufacturer:	Logic PD					
Date(s) of Test:	February 27th to June 29th 2012					
Project Engineer:	Khairul Aidi Zainal					
Test Engineer(s):	Adam Alger, Peter Feilen, Mike Hintzke, Aidi Zainal					
Voltage:	120 VAC					
Operation Mode:	Continuous transmit, modulated mode					
Environmental Conditions in the Lab:	Temperature: 70° F Relative Humidity: 30 %					
EUT Power:	X	Single Phase 120VAC		3 Phase ___VAC		
		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 (other than the fundamentals and its harmonics):

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
420.0	1.43	206	34.9	46.0	11.1	Vertical	Vertical
520.0	1.00	307	36.9	46.0	9.1	Vertical	Side
522.0	1.72	185	39.2	46.0	6.8	Horizontal	Flat
780.0	1.00	168	37.7	46.0	8.3	Horizontal	Flat
420.0	2.26	145	37.8	46.0	8.2	Horizontal	Side
520.0	1.75	215	39.8	46.0	6.2	Horizontal	Vertical
97.3	1.92	266	20.9	43.5	22.6	Horizontal	Vertical
98.7	1.00	241	29.2	43.5	14.3	Vertical	Flat
99.0	1.00	238	30.9	43.5	12.6	Vertical	Side
98.6	1.00	228	30.4	43.5	13.1	Vertical	Vertical

Note:
1. H: Horizontal, V: Vertical, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.

RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of radiated emissions of channel 2402 MHz in the restricted band:

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	1.05	206	58.3	53.9	63.5	9.6	Vertical	Flat
12010	1.02	61	55.6	44.7	63.5	18.8	Vertical	Side
19216	1	130	54.3	42.6	63.5	20.9	Vertical	Side

The following table depicts the level of significant radiated emissions of channel 2440 MHz in the restricted band:

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	1.11	234	59.3	56.6	63.5	6.9	Horizontal	Flat
7320	1	148	55.6	51.1	63.5	12.4	Horizontal	Side
12200	1	57	56.2	46.6	63.5	17.0	Horizontal	Side
19520	1	165	52.6	40.9	63.5	22.6	Vertical	Flat

The following table depicts the level of significant radiated emissions of channel 2480 MHz in the restricted band:

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	1.175	90.8	64.7	62.5	63.5	1.0	Vertical	Side
7440	1.19	226	0.0	46.3	63.5	17.2	Horizontal	Flat
12400	1	177	54.5	43.8	63.5	19.8	Horizontal	Flat
19840	1.04	202.6	52.5	41.3	74.0	32.7	Horizontal	Flat

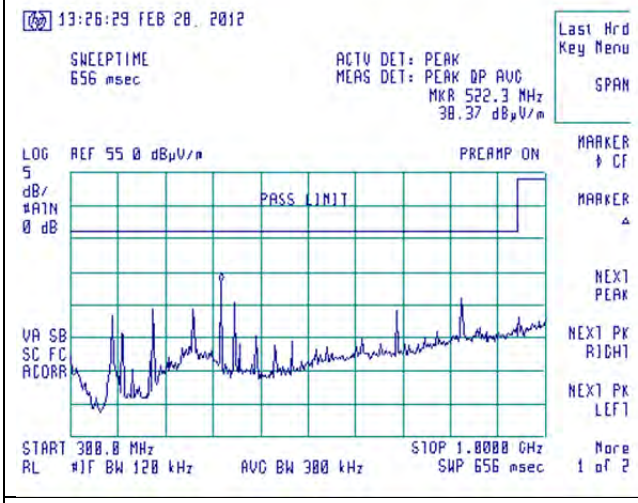
Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.

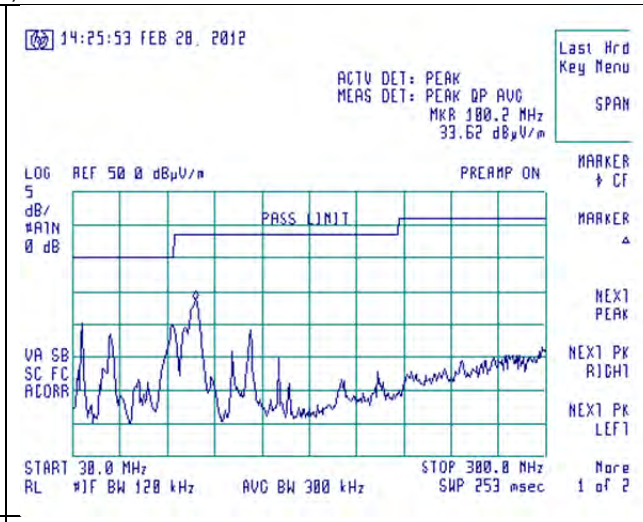
5.7 - Screen Captures - Radiated Emissions Test

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.

30 to 300 MHz, 3m distance.

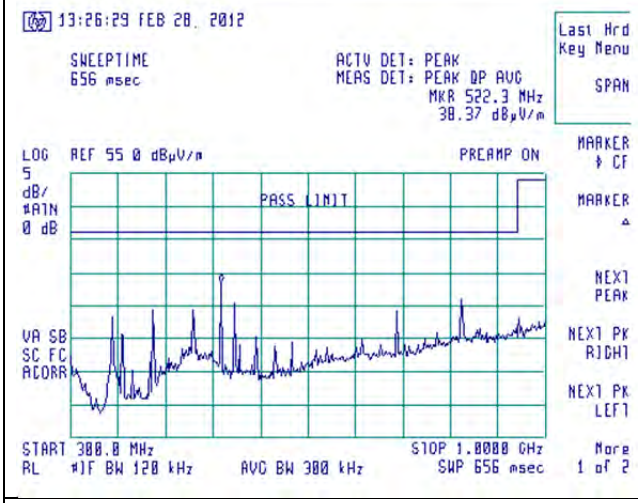


Horizontal Polarization

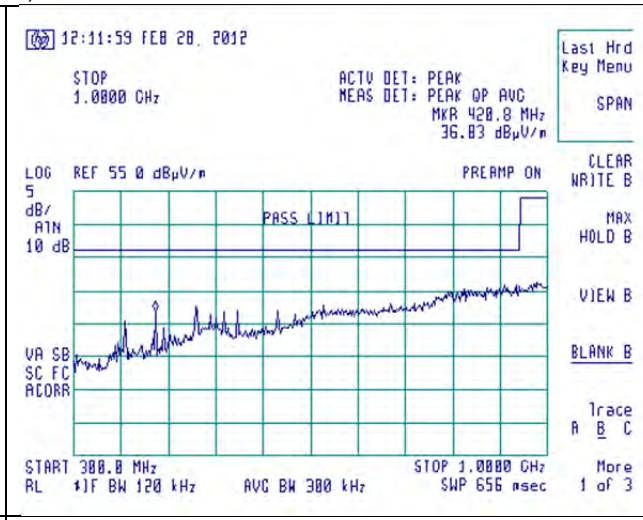


Vertical Polarization

300 to 1000 MHz, 3m distance.

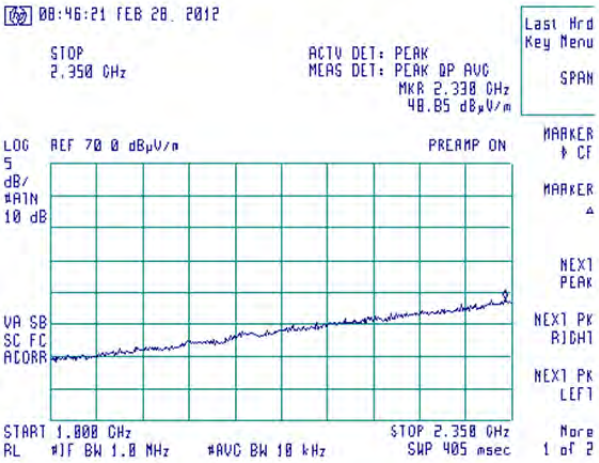


Horizontal Polarization

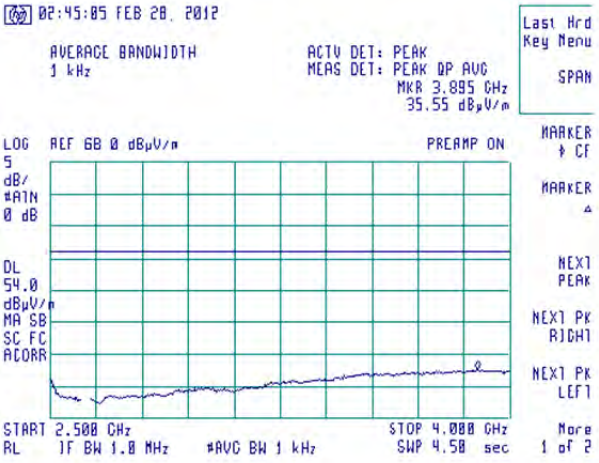


Vertical Polarization

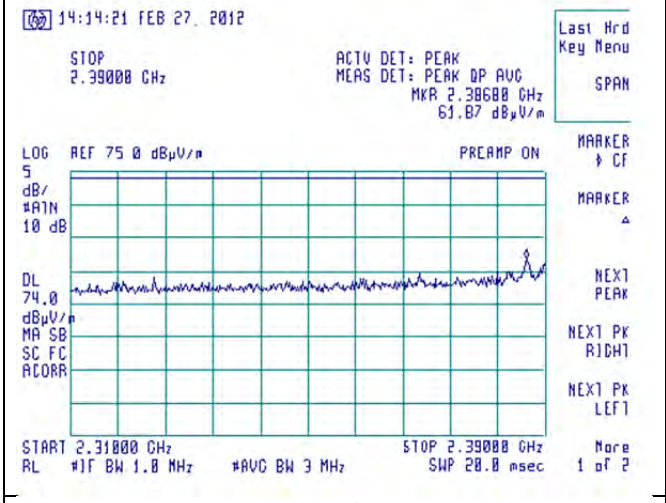
1000 to 2310 MHz, 3m distance.



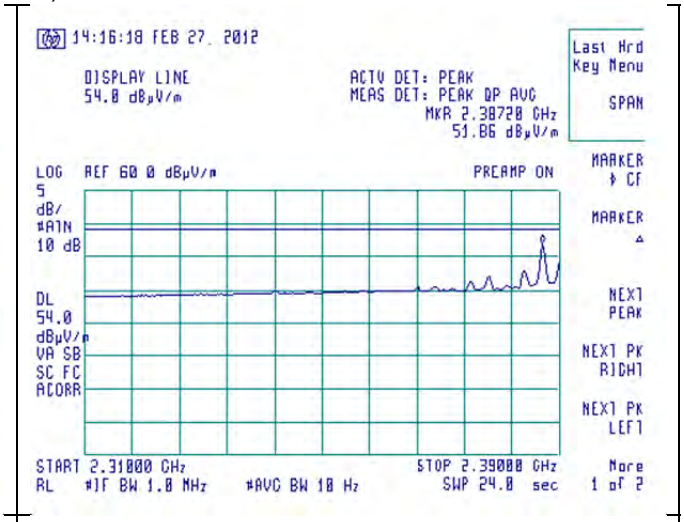
2500 to 4000 MHz, 3m distance.



2310 to 2390 MHz, 3m distance



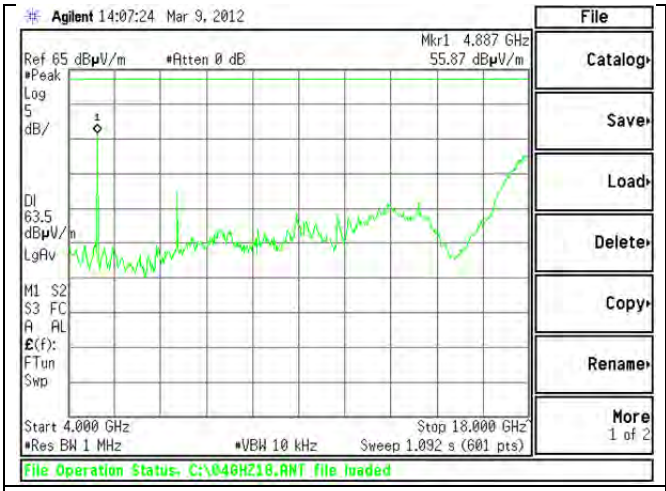
Peak



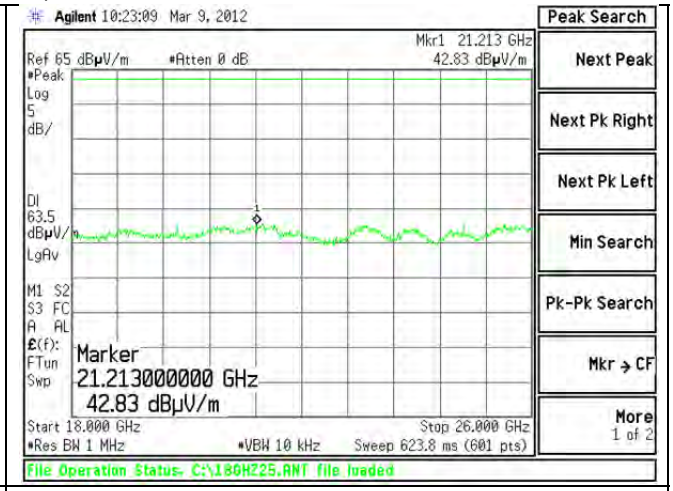
AVG

Note: The range of 2483.5 to 2500 MHz is in section 8 of this report (Band-edges).

4000 to 26000 MHz, 1m distance.



4000 to 18000 MHz



18000 to 26000 MHz

EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

6.1 - Test Setup

The test area and setup are in accordance with ANSI C63.4-2003 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

6.2 - Test Procedure

The EUT was investigated in continuous modulated transmit mode and continuous receive mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

Customer supplied DC power supply was used during the test to supply the EUT with the appropriate DC voltage.

6.3 - Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. Calibrations of the LISN and Limiter are traceable to N.I.S.T. All cables are calibrated and checked periodically for conformance. The emissions are measured on the EMI Receiver, which has automatic correction for all factors stored in memory and allows direct readings to be taken.

6.4 - Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC CFR 47 Part **15.207** and **15.107**, Conducted Emissions. See the Data Charts and Graphs for more details of the test results. By virtue of meeting the requirements of FCC, the EUT also meets the requirements of IC **RSS 210** and **RSS GEN**.

6.5 - FCC Limits of Conducted Emissions at the AC Mains Ports

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

6.6 - CONDUCTED EMISSIONS TEST DATA CHART

Manufacturer:	LS Research					
Date(s) of Test:	April 2nd 2012					
Project Engineer:	Khairul Aidi Zainal					
Test Engineer:	Mike Hintzke					
Voltage:	120 VAC					
Operation Mode:	Continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 40%					
Test Location:	X	AC Mains Test area				Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane				10cm Spacers
	X	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:		Peak	X	Quasi-Peak	X	Average

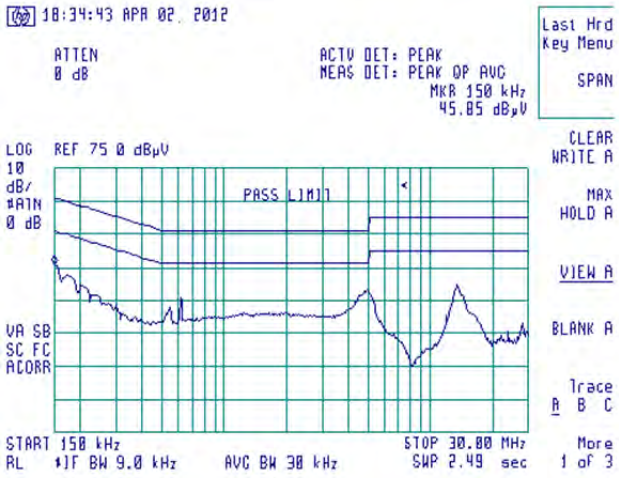
		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµ V)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµ V)	Average Margin (dB)
0.150	L1	42.2	66.0	23.8	25.4	56.0	30.6
0.621	L1	29.3	56.0	26.7	24.0	46.0	22.0
4.897	L1	34.3	56.0	21.7	28.6	46.0	17.4
13.520	L1	32.6	60.0	27.4	22.4	50.0	27.6
0.150	L2	41.7	66.0	24.3	26.8	56.0	29.2
4.905	L2	33.9	56.0	22.1	28.3	46.0	17.7
13.510	L2	35.3	60.0	24.7	26.2	50.0	23.8

Notes:

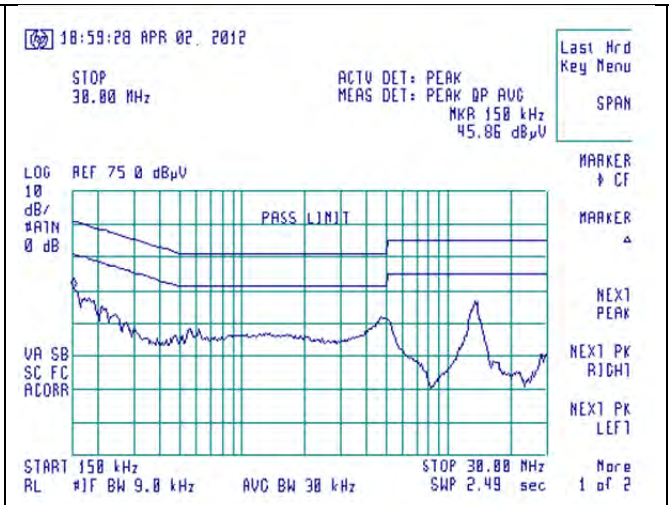
1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

6.7 Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).



Line 1



Line 2

6.8 Screen Captures – Conducted Emissions Test

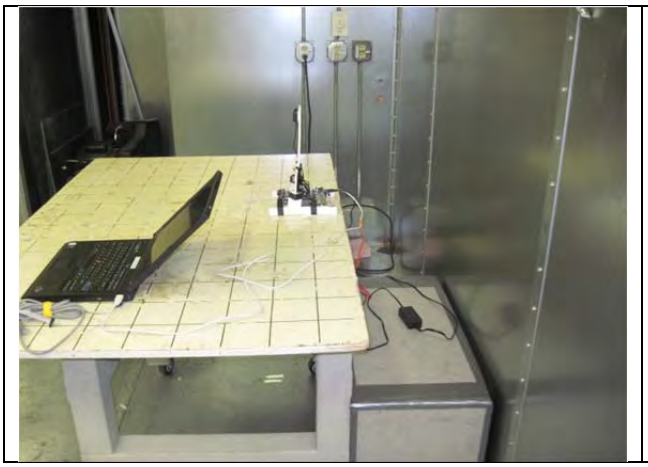


EXHIBIT 7. OCCUPIED BANDWIDTH

Test Engineer: Aidi Zainal and Peter Feilen

7.1 - Limits

Per FCC CFR 47 15.247 frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, as is the case with this device, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

7.2 - Method of Measurements

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 cable and the attenuator were 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.

Measurement method used was FCC OET Public Notice DA 00-705.

7.3 - Test Data

7.3.1 GFSK (1MBPS)

	Bandwidth	
Frequency (MHz)	99% (kHz)	20dB (kHz)
2402.0	**883.5**	**803.0**
2440.0	**841.4**	**787.0**
2480.0	**886.5**	**790.0**

7.3.2 EDR2 (2MBPS)

	Bandwidth	
Frequency (MHz)	99% (kHz)	20dB (kHz)
2402.0	**1234.7**	**1376.0**
2440.0	**1243.2**	**1400.0**
2480.0	**1228.6**	**1350.0**

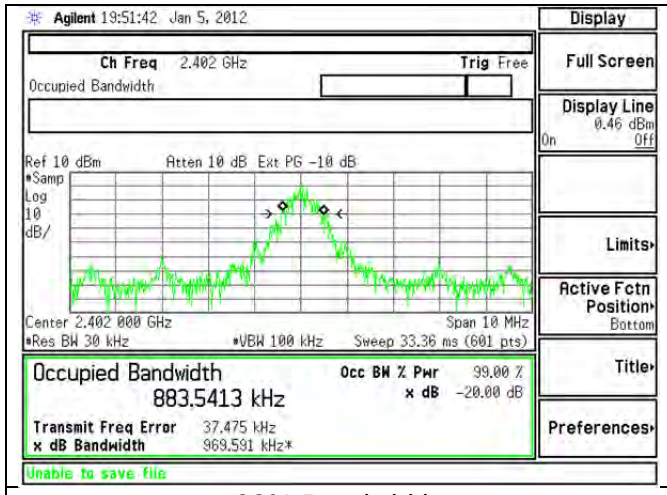
7.3.3 EDR3 (3MBPS)

	Bandwidth	
Frequency (MHz)	99% (kHz)	20dB (kHz)
2402.0	**1273.9**	**1357.0**
2440.0	**1292.2**	**1293.0**
2480.0	**1268.1**	**1350.0**

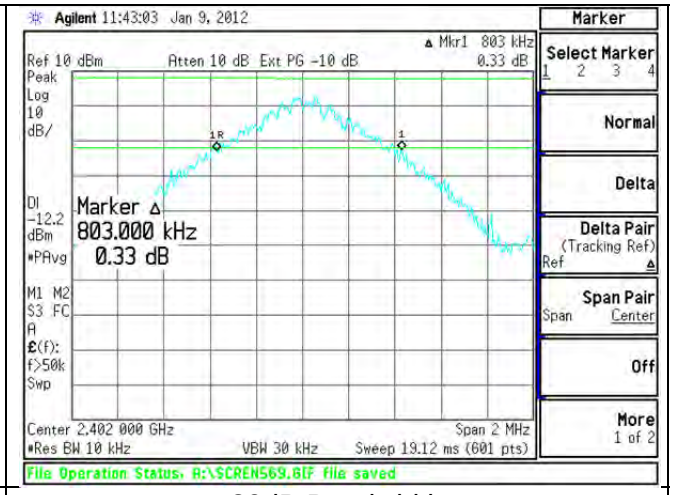
7.4 – Screen Captures

7.4.1 GFSK (1MBPS)

Channel 2402MHz

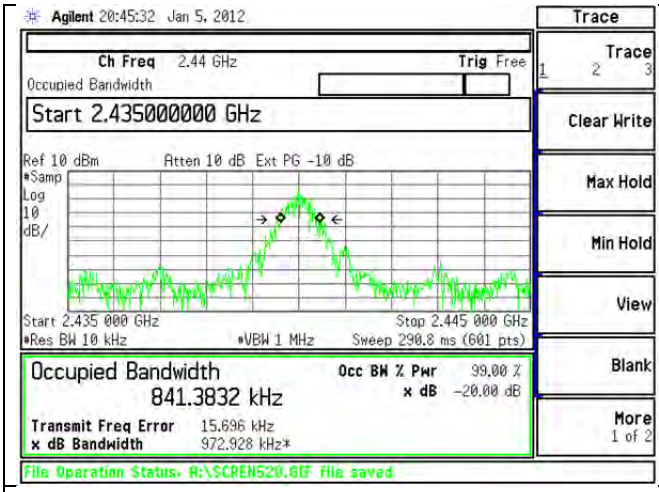


99% Bandwidth

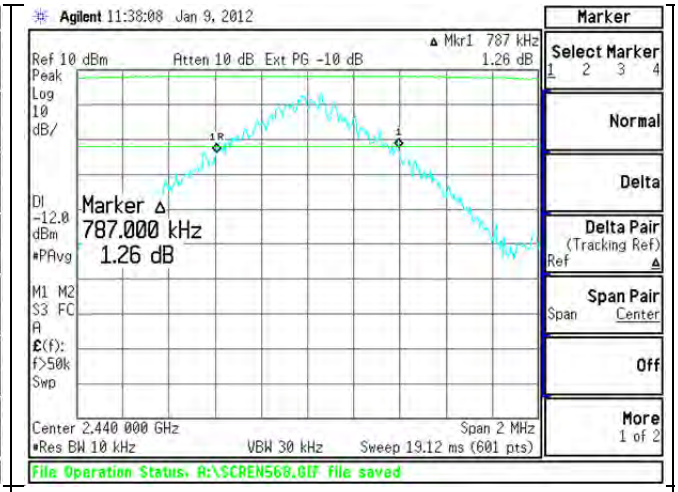


20dB Bandwidth

Channel 2440MHz

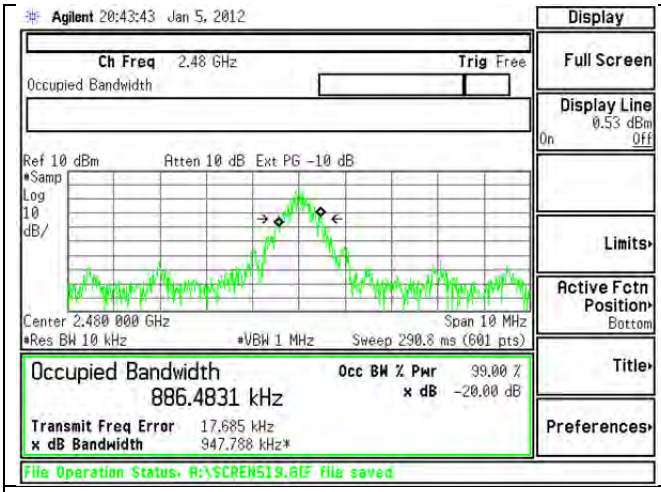


99% Bandwidth

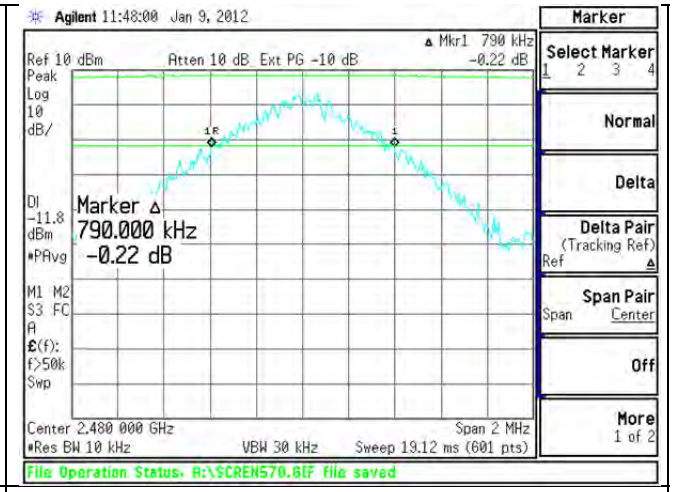


20dB Bandwidth

Channel 2480MHz



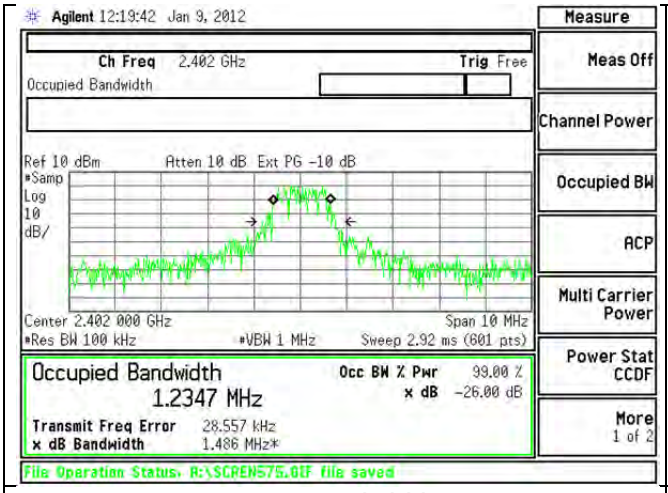
99% Bandwidth



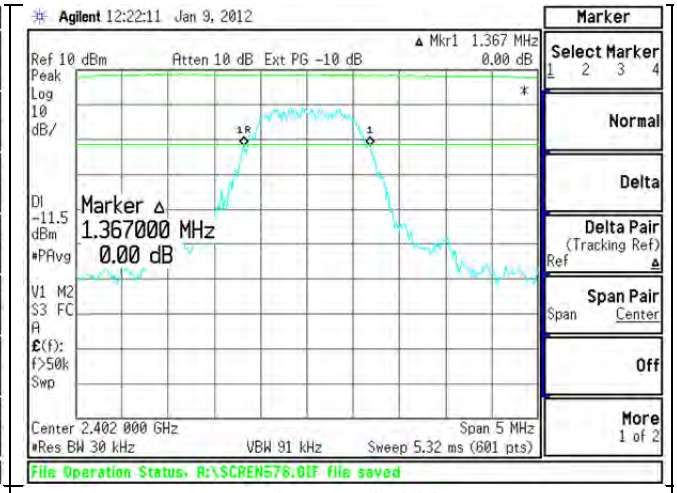
20dB Bandwidth

7.4.2. EDR2 (2MBPS)

Channel 2402MHz

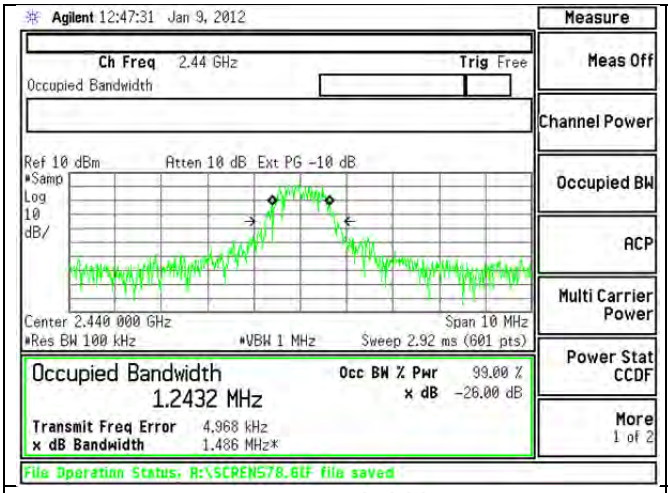


99% Bandwidth



20dB Bandwidth

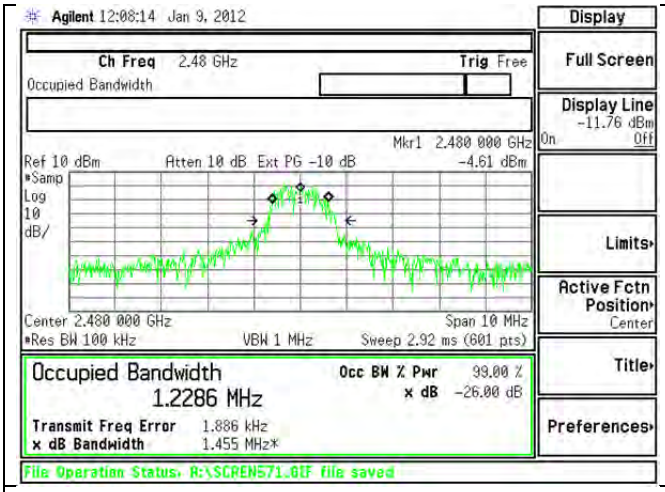
Channel 2440MHz



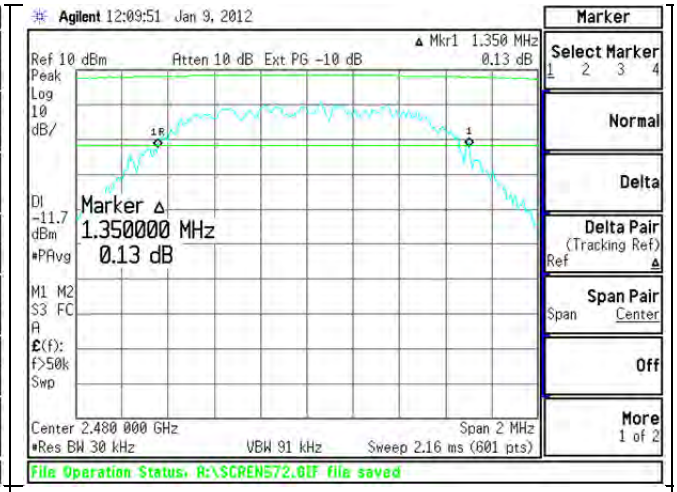
99% Bandwidth

20dB Bandwidth

Channel 2480MHz



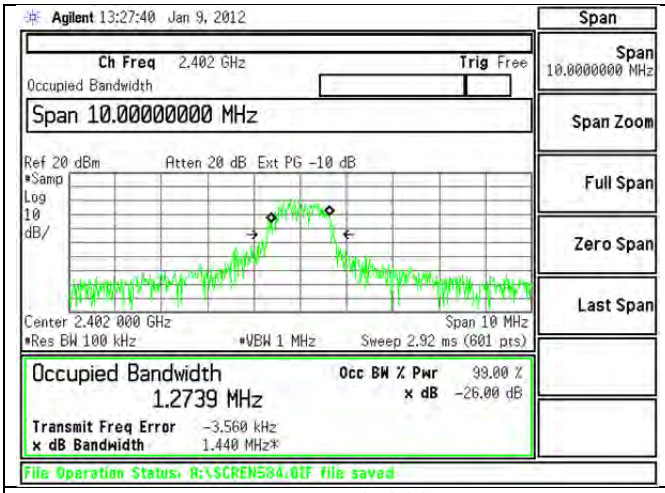
99% Bandwidth



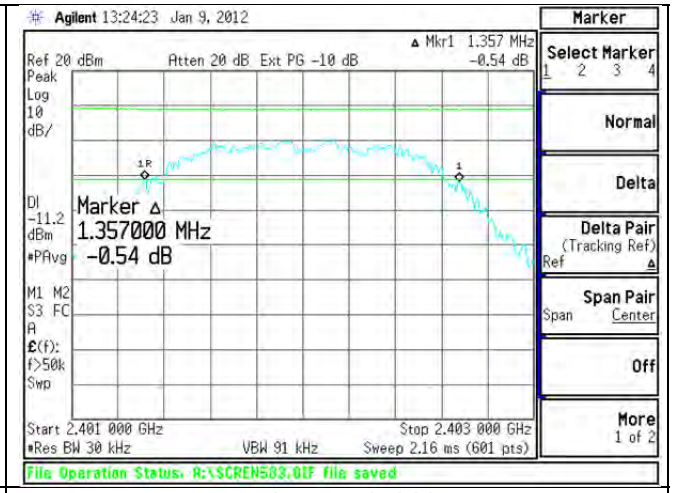
20dB Bandwidth

7.4.2. EDR3 (3MBPS)

Channel 2402MHz

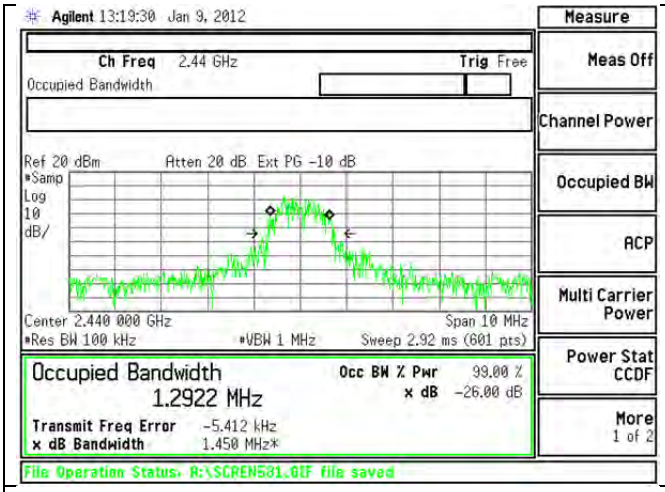


99% Bandwidth

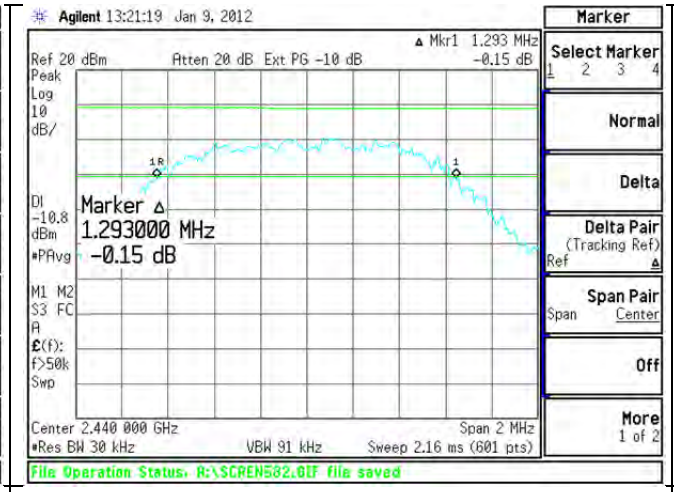


20dB Bandwidth

Channel 2440MHz

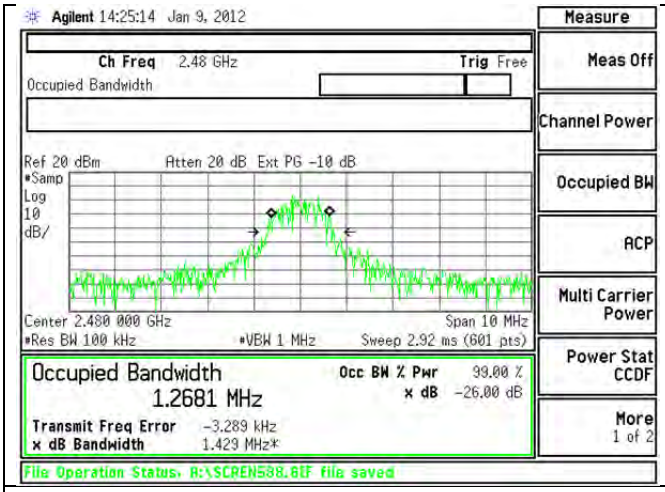


99% Bandwidth

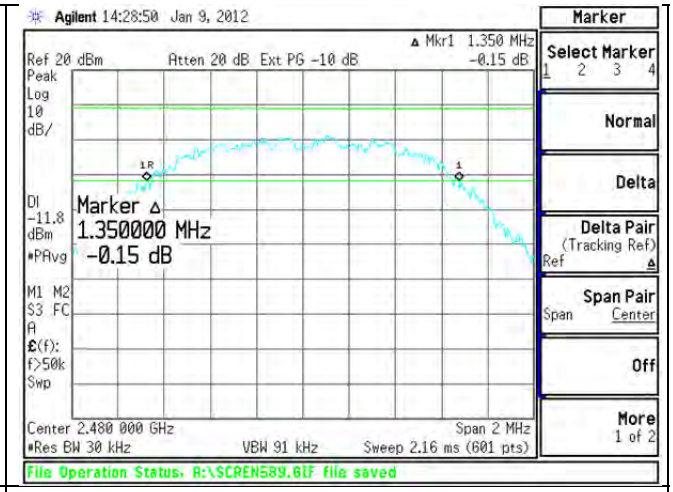


20dB Bandwidth

Channel 2480MHz



99% Bandwidth



20dB Bandwidth

EXHIBIT 8. BAND EDGE MEASUREMENTS

Test Engineer: Aidi Zainal, Peter Feilen

8.1 - Method of Measurements

FCC 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in RSS GEN and also to the limits in the applicable annex. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

The Band-edge measurements were performed conducted and radiated. The measurement of band-edge was performed to satisfy FCC 15.247(d).

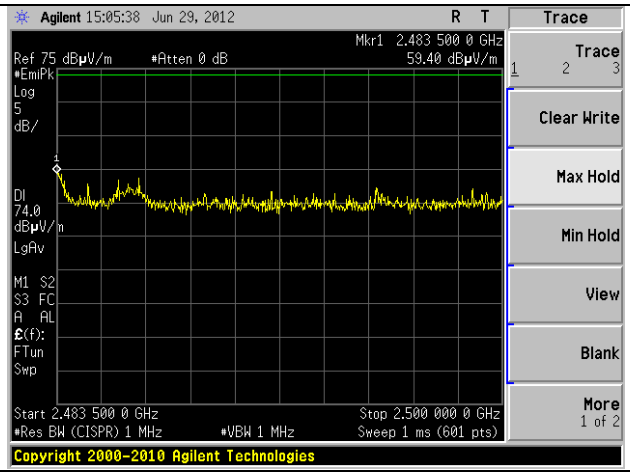
Conducted measurements of the spurious emission were performed with a measurement bandwidth of 100kHz.

Measurement method used was FCC OET Public Notice DA 00-705.

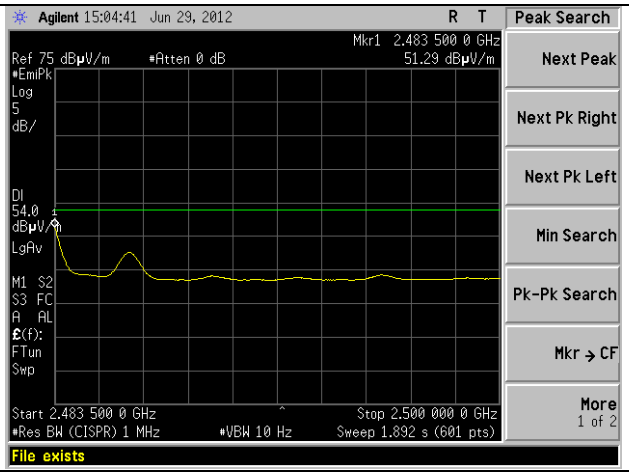
8.2. Band edge captures.

8.2.1 Radiated Band-edge in Restricted Band:

8.2.1.1 Bluetooth GFSK

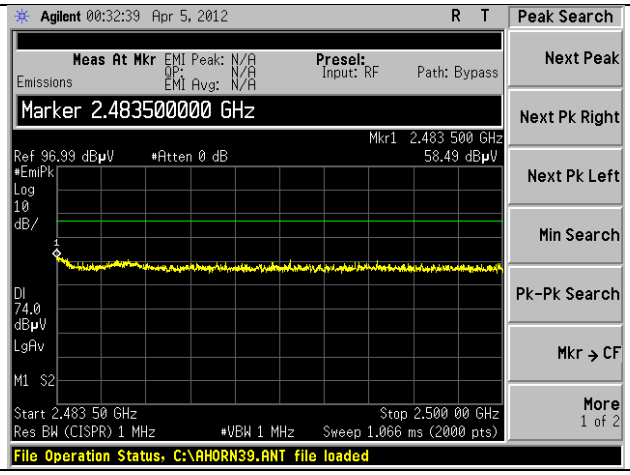


Upper band edge Peak

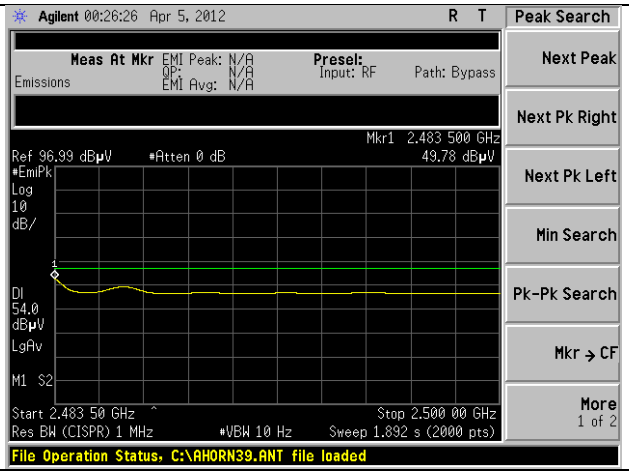


Upper band edge Average

8.2.1.2 Bluetooth EDR2

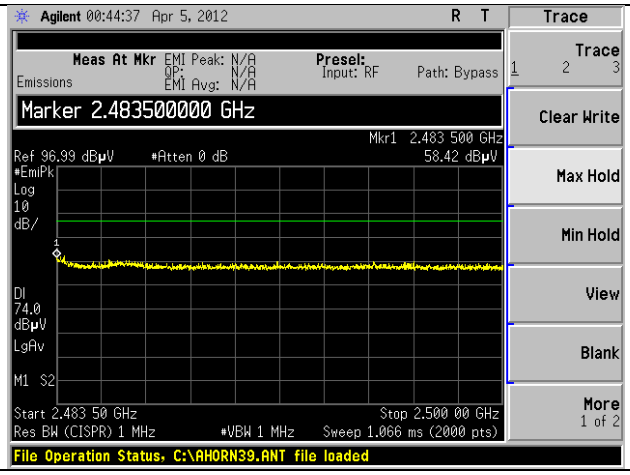


Peak

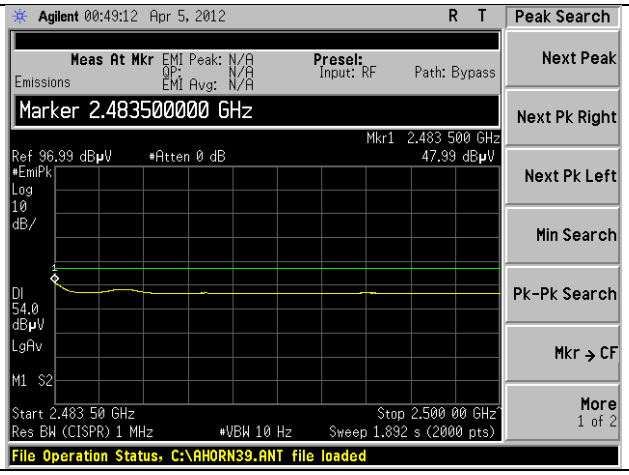


Average

8.2.1.3 Bluetooth EDR3



Peak

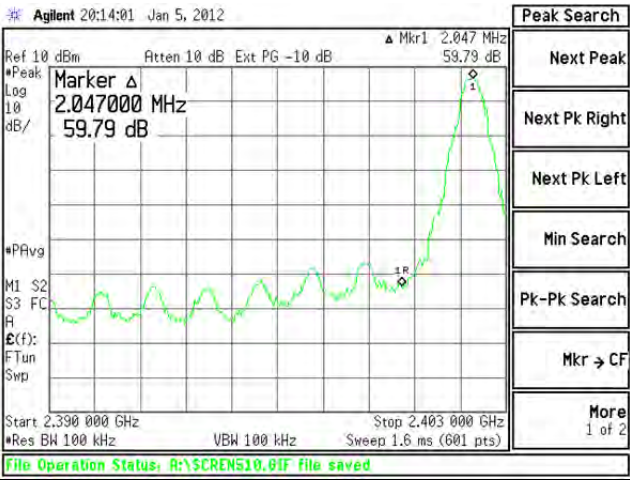


Average

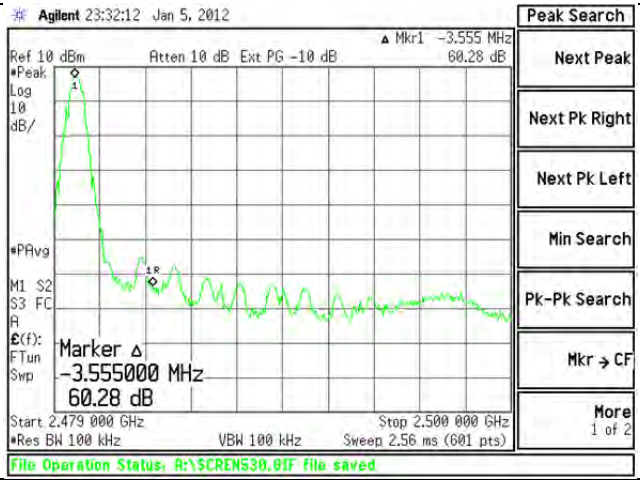
8.2.2 Conducted Band-edge:

8.2.2.1 GFSK

A. Continuously transmitting and modulated.

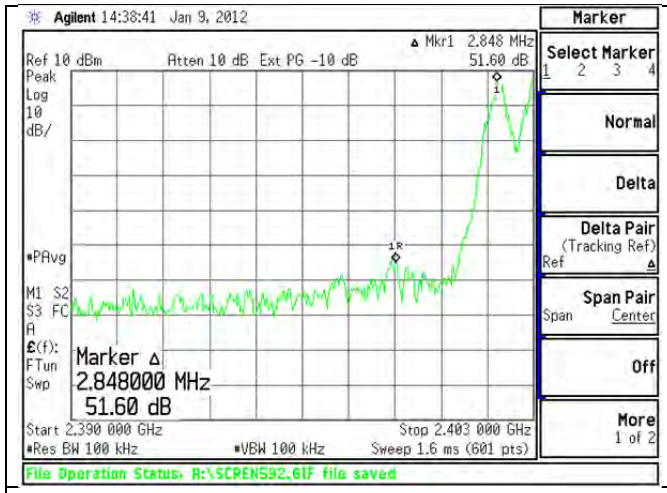


Lower band edge

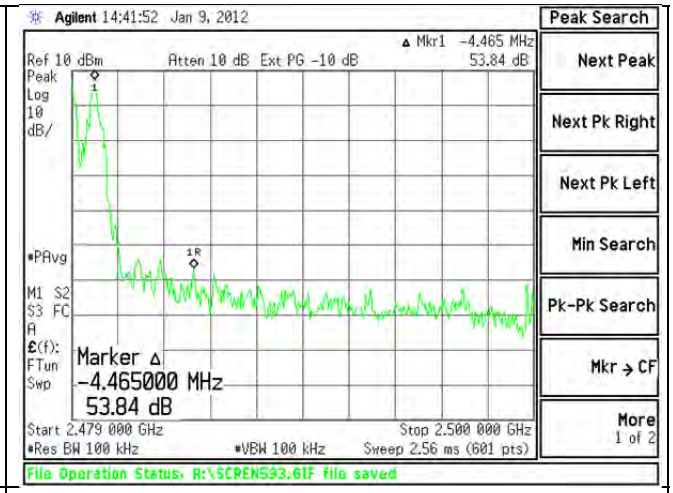


Upper band edge

B. **Hopping mode.**



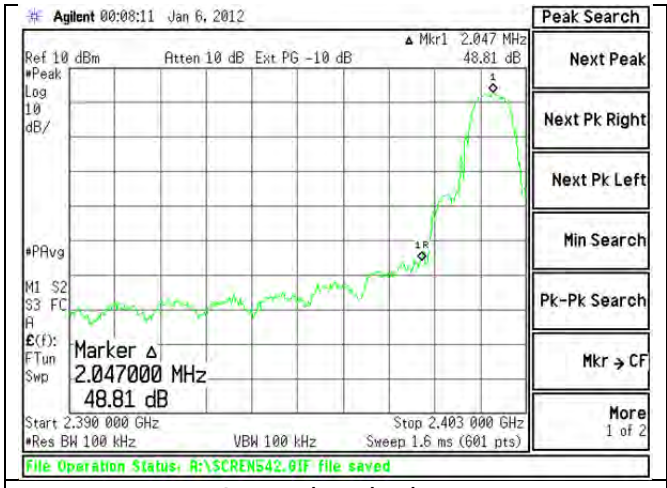
Lower band edge



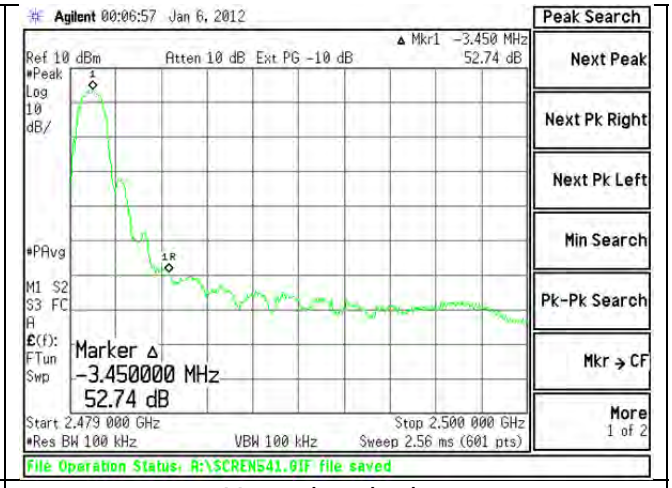
Upper band edge

8.2.2.2 EDR2

A. Continuously transmitting and modulated.

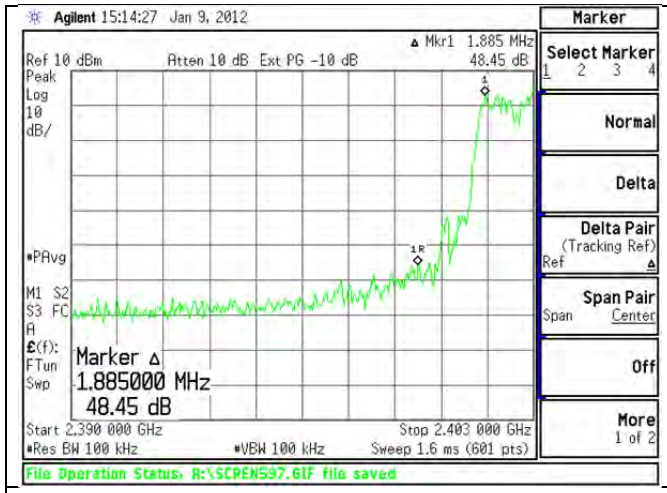


Lower band edge

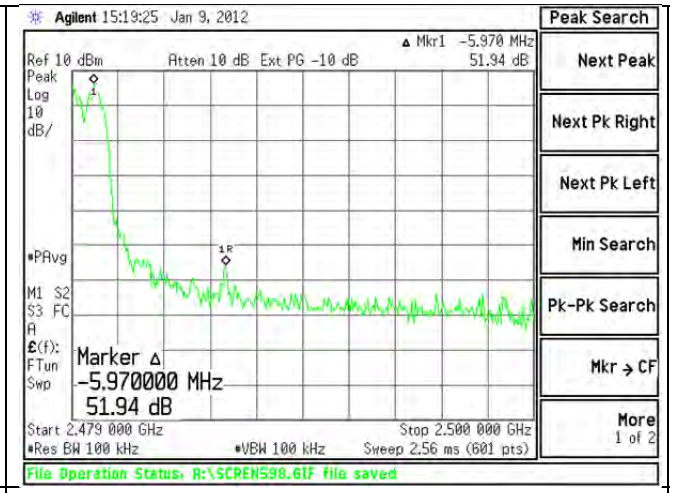


Upper band edge

B. **Hopping mode.**



Lower band edge

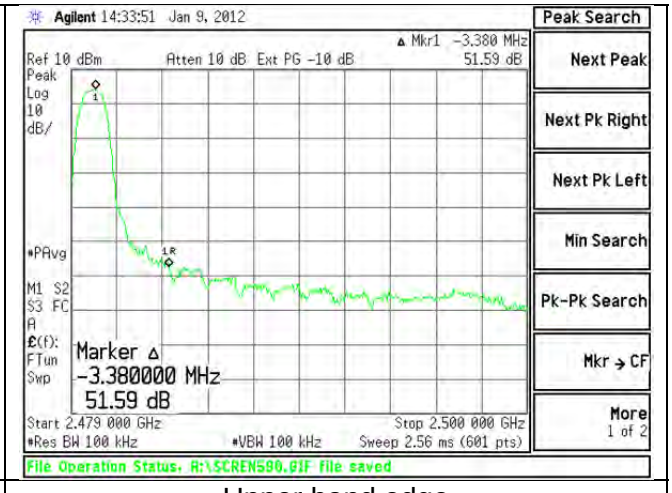


Upper band edge

8.2.2.3 EDR3

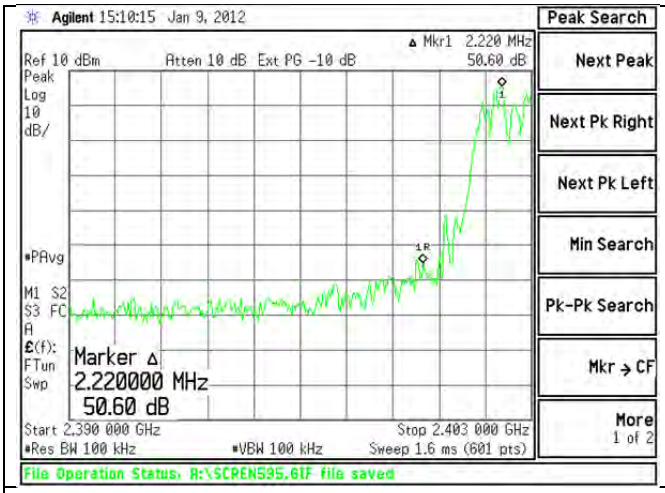
A. Continuously transmitting and modulated.

Lower band edge

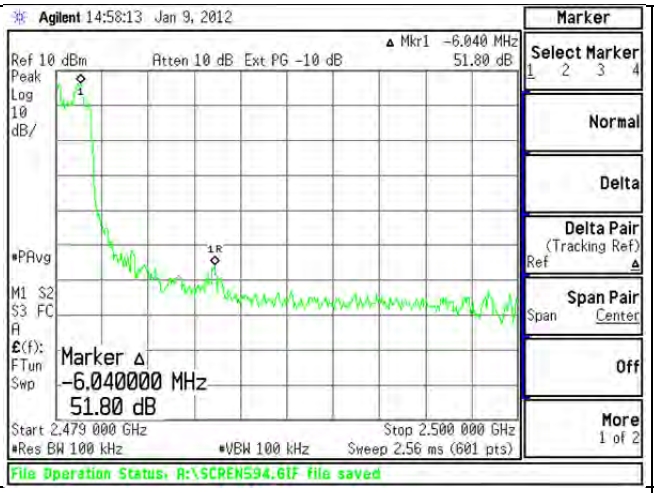


Upper band edge

B. **Hopping mode.**



Lower band edge



Upper band edge

EXHIBIT 9. POWER OUTPUT (CONDUCTED)

Test Engineer: Mike Hintzke

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with resolution bandwidths set to 3 MHz and a span of 10 MHz.

Measurement method used was FCC OET Public Notice DA 00-705.

9.2 - Test Data

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).

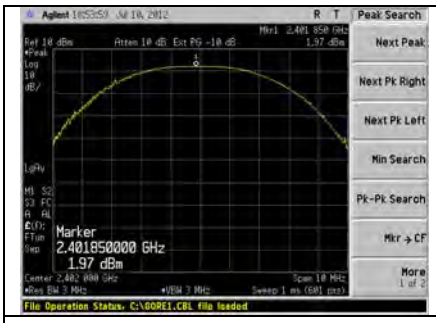
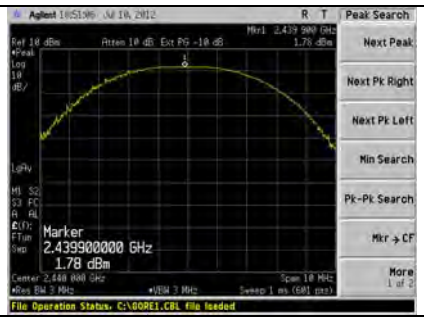
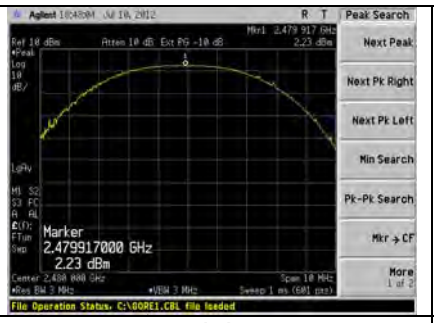
Generic example of reported data at 2440 MHz:

Reported Measurement data = 0.93 (raw receiver measurement in dBm) + 0.85 (cable factor in dB) = 1.78 (dBm).

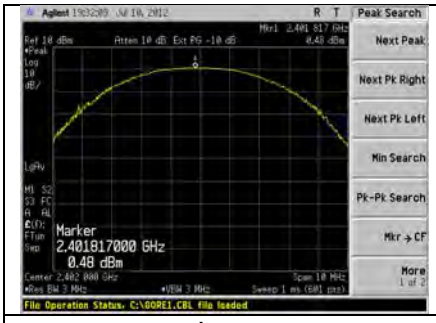
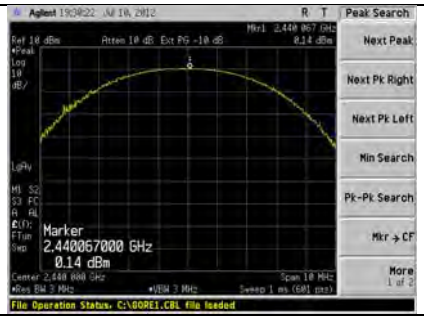
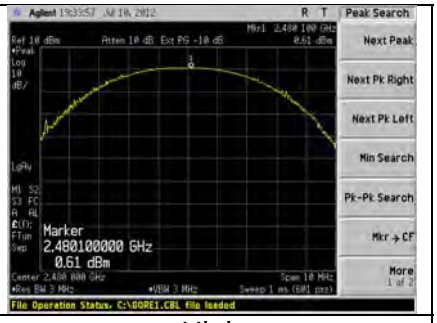
Modulation	Channel	Frequency (MHz)	Pout (dBm)	Limit (dBm)	Margin (dB)
GFSK	0	2402	1.97	21.00	19.0
	19	2440	1.78	21.00	19.2
	39	2480	2.23	21.00	18.8
EDR2	0	2402	0.48	21.00	20.5
	19	2440	0.14	21.00	20.9
	39	2480	0.61	21.00	20.4
EDR3	0	2402	1.14	21.00	19.9
	19	2440	0.86	21.00	20.1
	39	2480	1.28	21.00	19.7

9.3 - Screen Captures – Power Output (Conducted)

9.3.1 GFSK

		
Low	Middle	High

9.3.1 EDR2

		
Low	Middle	High

9.3.1 EDR3

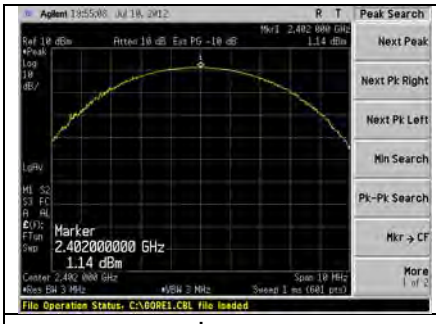
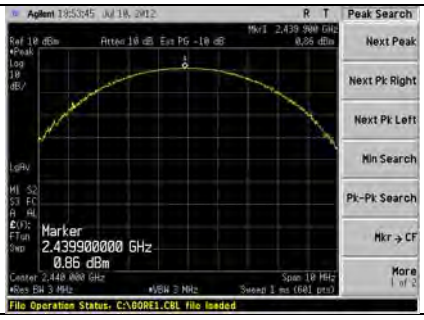
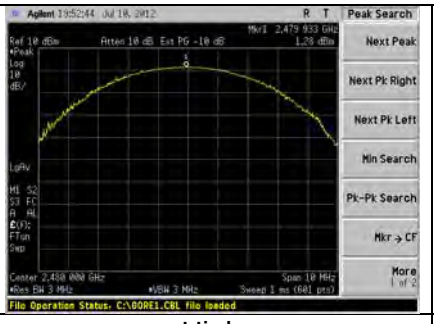
		
Low	Middle	High

EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

Test Engineer: Peter Feilen

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.

10.2 – 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.

Measurement method used was FCC OET Public Notice DA 00-705.

10.3- Test Data

	Channel low	Channel middle	Channel high
Fundamental	1.4	1.5	1.9
2nd Harmonic	-74.2	-67.7	-64.1
3rd Harmonic	-59.2	-59.8	-59.8
4th Harmonic	-64.3	-65.0	-61.9
5th Harmonic	-57.7	-55.3	-54.2
6th Harmonic	-59.6	-58.5	-56.4
7th Harmonic	-69.3	NOTE2	NOTE2
8th Harmonic	-69.2	-66.6	NOTE2
9th Harmonic	NOTE2	NOTE2	NOTE2
10th Harmonic	NOTE2	NOTE2	NOTE2

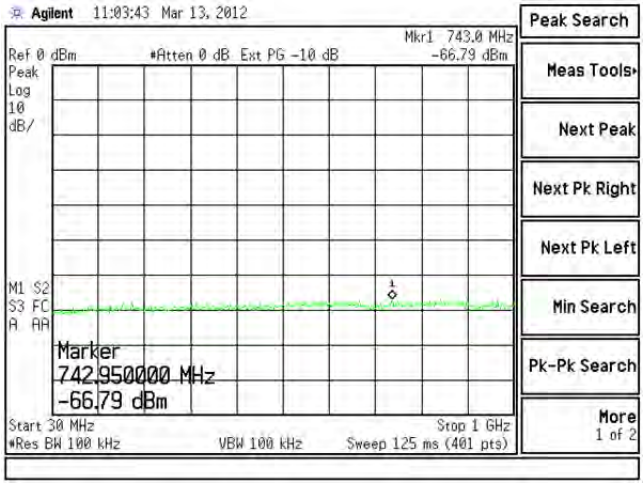
Note:
1. **All reported data are in dBm**.
2. **Spurious emission buried within system noise floor**.

The table below lists other notable spurious emissions other than the harmonics.

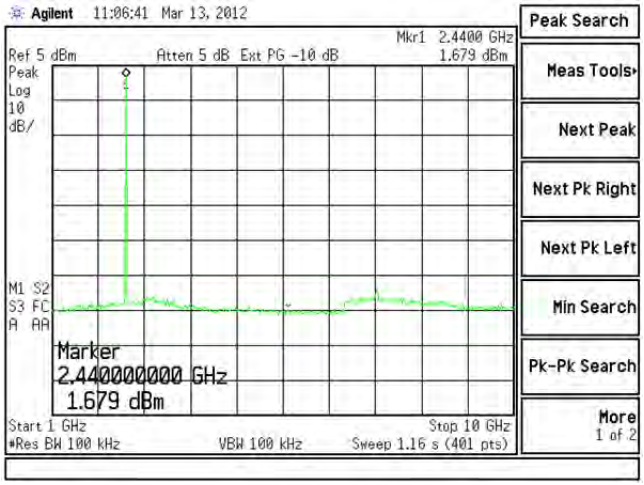
Freq(MHz)	Chan	level(dBm)
2470.00	LOW	-59.9
3205.00	LOW	-61.9
440.60	LOW	-65.3
801.20	LOW	-73.7
2365.00	MID	-58.8
2515.00	MID	-57.8
2560.00	HIGH	-56.4
519.80	HIGH	-71.6

10.4- Screen Captures – Spurious Radiated Emissions

30 MHz to 1000 MHz



900 MHZ to 1000 MHz



1000 MHZ to 10000 MHz

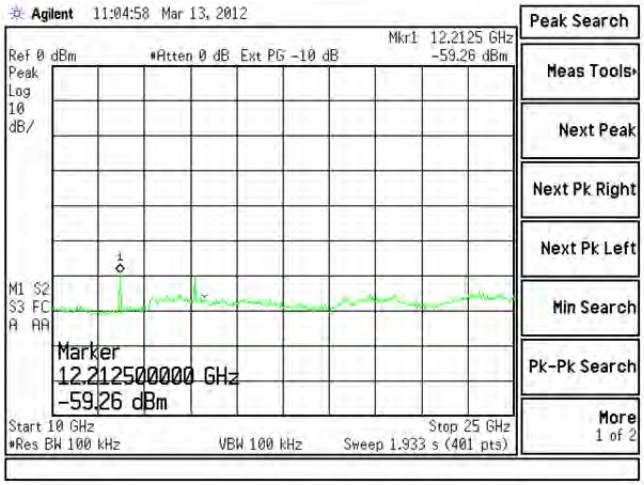


EXHIBIT 11. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

Test Engineer(s): Khairul Aidi Zainal

The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied ±15% from the nominal.

4.25		5.0		5.75		
Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Channel
2.0	2402000459	**2.0**	2402000479	**2.0**	2402000479	0
1.8	2440000560	**1.8**	2440000560	**1.8**	2440000539	19
2.2	2480000580	**2.2**	2480000560	**2.2**	2480000539	39

Channel	max	min	freq drift (Hz)
0	2402000479	2402000459	20
19	2440000560	2440000539	21
39	2480000580	2480000539	41

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

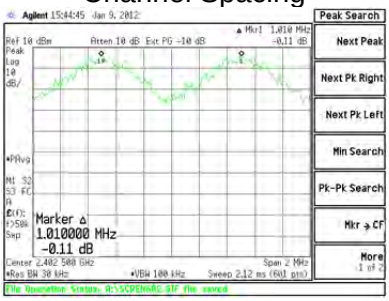
EXHIBIT 12. CHANNEL PLAN AND SEPARATION

Test Engineer: Aidi Zainal

A spectrum analyzer was used with a resolution bandwidth of 30 kHz to measure the channel separation of the EUT.

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

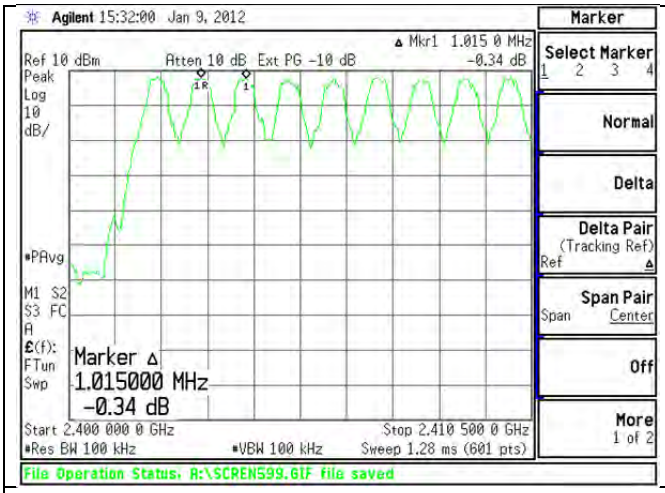
Channel Spacing



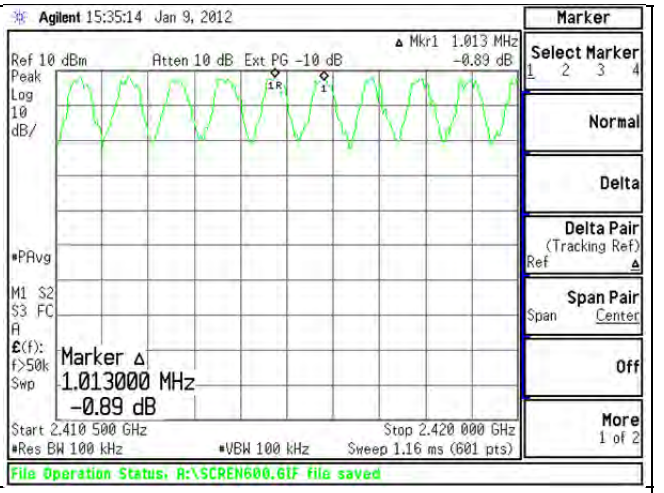
Channel separation = <u>1.010 MHz</u>

RANGE (MHz)	# OF CHANS
2400 - 2410.5	9.0
2410.5 - 2420	9.5
2420 - 2430	10.0
2430 - 2440	10.0
2440-2450	10.0
2450-2460	10.0
2460-2470	10.0
2470-2483.5	10.5

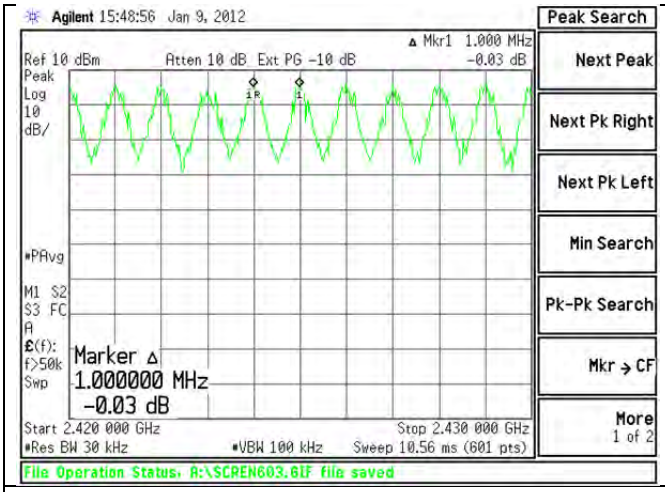
Total Channels	79



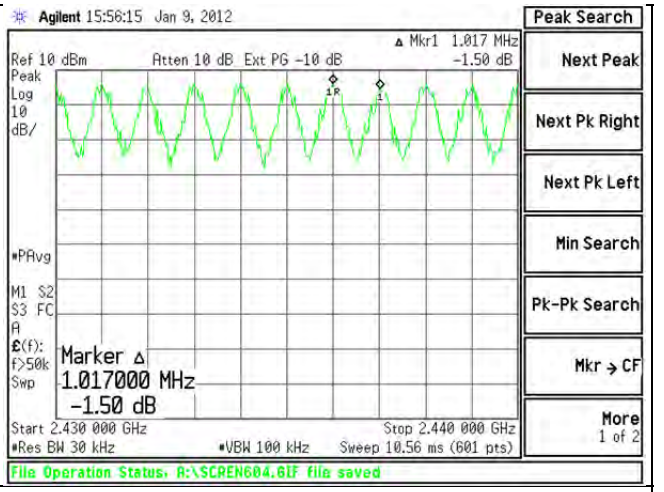
2400 TO 2410.5 MHz



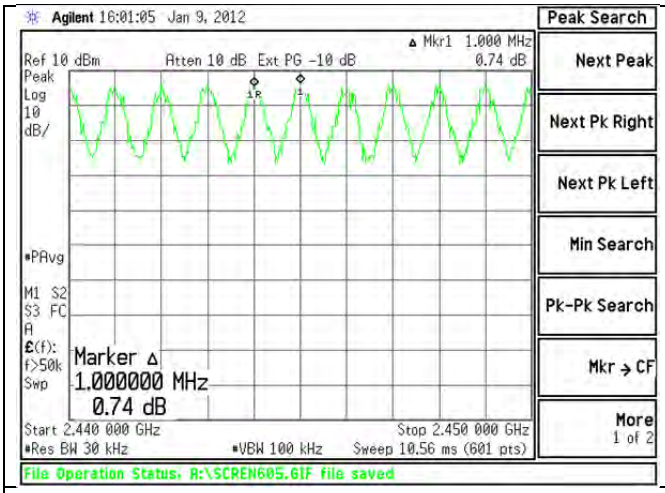
2410.5 TO 2420 MHz



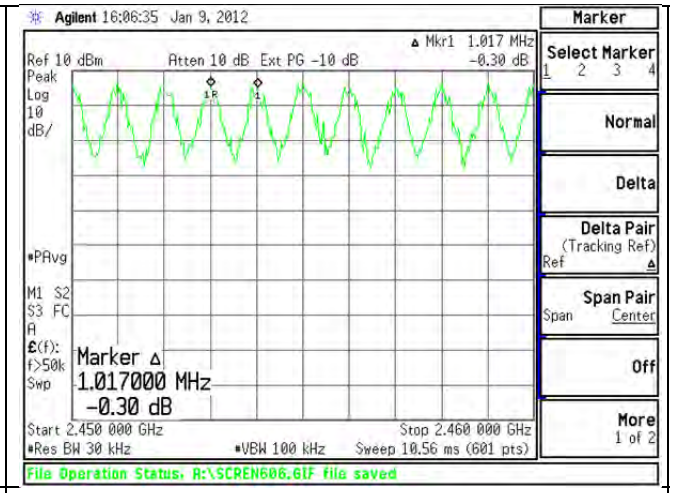
2420 TO 2430 MHz



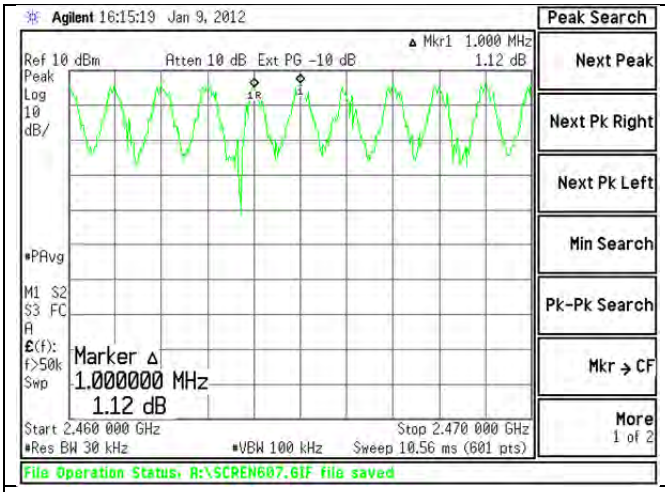
2430TO 2440 MHz



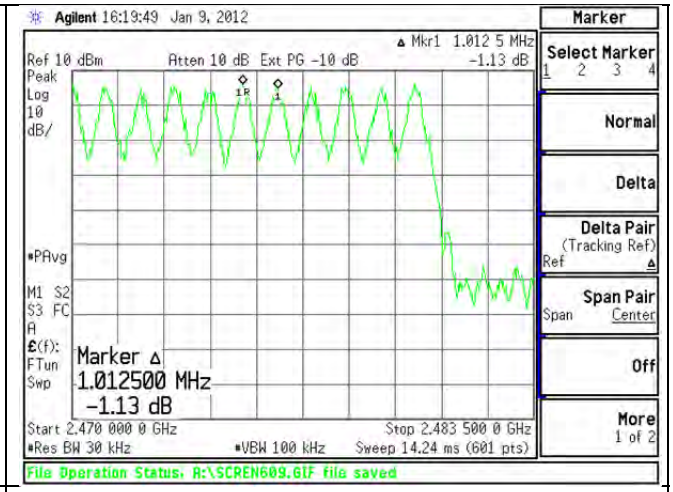
2440 TO 2450 MHz



2450TO 2460 MHz



2460 TO 2470 MHz



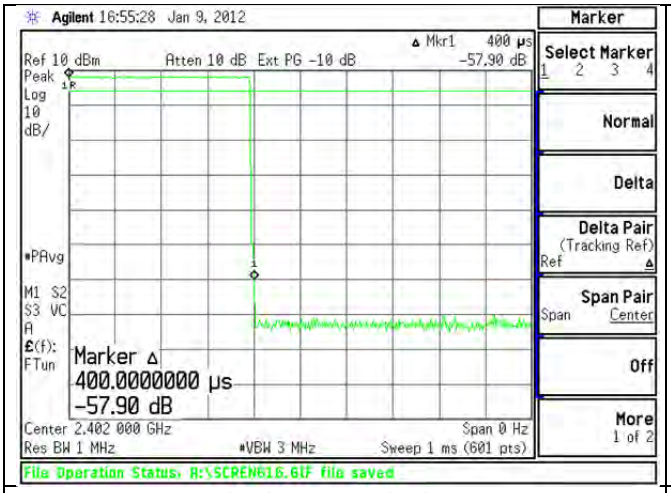
2470TO 2483.5 MHz

EXHIBIT 13. CHANNEL OCCUPANCY

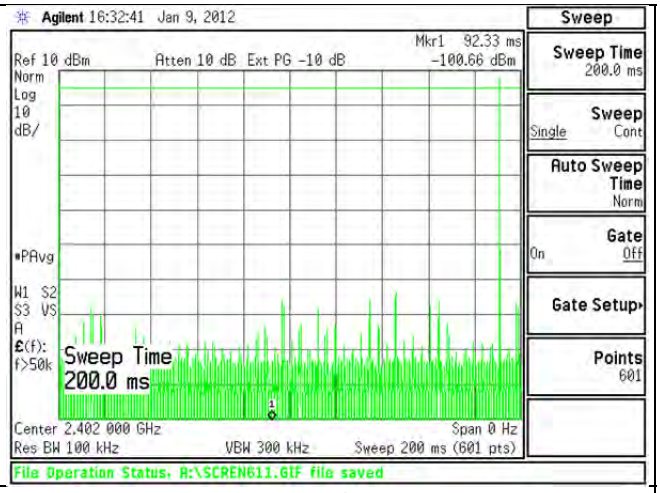
Part 15.247(a)(1) requires a channel occupancy, for this device, of no more than 400 milliseconds in a 31.6 second window. The channel occupancy for this EUT was measured using a spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths 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.

A longest single transmission is 401.7µs. The maximum occupancy in a **200ms** window is **3** (three) transmission cycle. In 31.6 seconds there are 474 transmission cycles which add up to **19.4ms** total occupancy.

Plots of Channel Occupancy

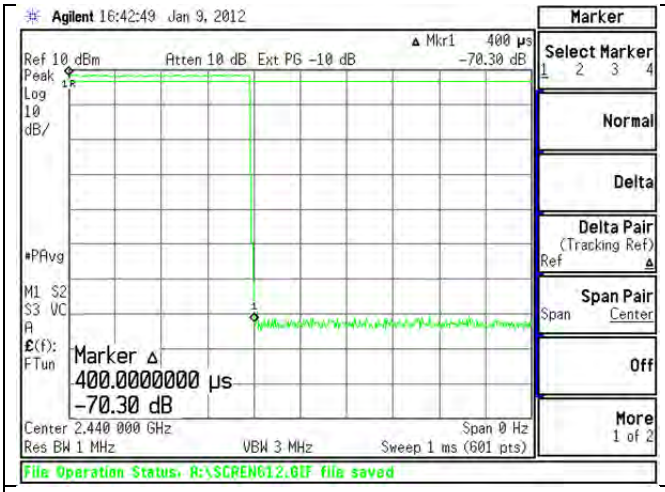


Single transmission

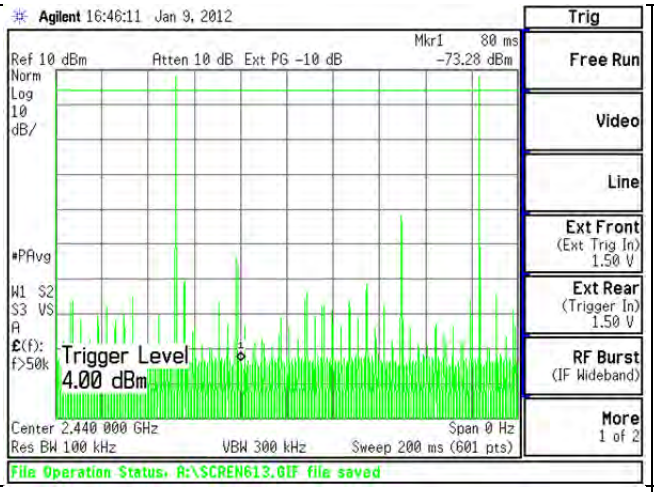


Occupancy in 200ms

Channel 914.6 MHz

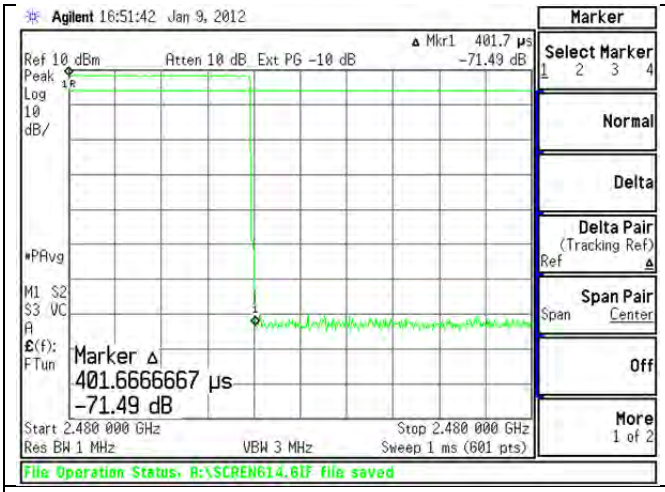


Single transmission

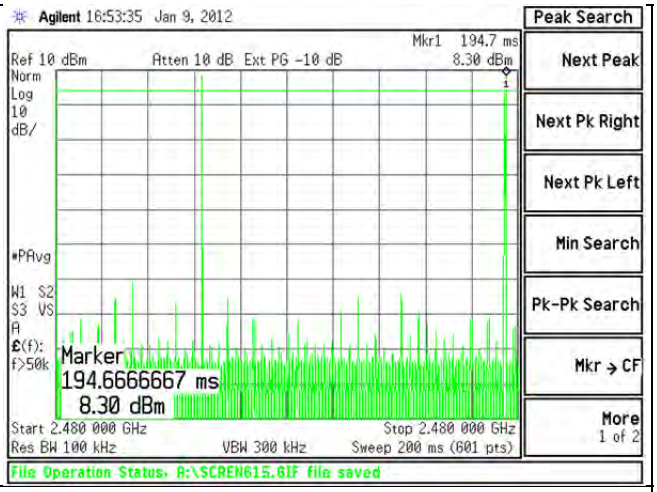


Occupancy in 200ms

Channel 926.4 MHz



Single transmission



Occupancy in 200ms

EXHIBIT 14. EQUAL CHANNEL USAGE AND PSEUDORANDOM HOPPING SEQUENCE.

By virtue of being an IEEE 802.15 Bluetooth device, the EUT is inherently compliant to the requirements.

EXHIBIT 15. RECEIVER SYNCHRONIZATION AND RECEIVER INPUT BANDWIDTH.

By virtue of being an IEEE 802.15 Bluetooth device, the EUT is inherently compliant to the requirements.

APPENDIX A – Test Equipment List

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 12-Dec-2011 Type Test: AC mains Job #: C-1333 and C-1489

Prepared By: Aidi Customer: Logic PD Quote #: 311310

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	11/22/2011	11/22/2012	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	11/22/2011	11/22/2012	Active Calibration
3	AA 960072	Transient Limiter	HP	11947A	3107A02515	11/22/2011	11/22/2012	Active Calibration
4	AA 960075	LISN	EMCO	3810/2NM	9612-1710	9/19/2011	9/19/2012	Active Calibration

Project Engineer: Aidi Zainal Quality Assurance: Mike Hintzke

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 12-Dec-2011 Type Test: Conducted measurements Job #: C-1333

Prepared By: Aidi Customer: Logic PD Quote #: 311310

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/1/2011	6/1/2012	Active Calibration
2	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	4/252011	4/252012	Active Calibration
3	CC 000221C	SpectrumAnalyzer	HP	E4407B	US39160256	5/4/2011	5/4/2012	Active Calibration

Project Engineer: Aidi Quality Assurance: Peter

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 21-Jun-2012 Type Test: Cond Measurements Job #: C-1489

Prepared By: Aidi Customer: Logic PD Quote #: 312142

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/1/2011	6/1/2013	Active Calibration
2	EE 960073	SpectrumAnalyzer	Agilent	E4446A	US45300564	5/9/2012	5/9/2013	Active Calibration
3	CC 000221C	SpectrumAnalyzer	HP	E4407B	US39160256	6/5/2012	6/5/2013	Active Calibration

Project Engineer: Aidi Zainal Quality Assurance: Mike Hintzke

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 21-Jun-2012 Type Test: Rad Band-Edge Job #: C-1333 and C-1489

Prepared By: Aldi Customer: Logic PD Quote #: 312142

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960157	3Hz-13.2GHz SpectrumAnalyzer	Agilent	E4445A	MY48250225	6/29/2012	6/29/2013	Active Calibration
2	EE 960158	RF Preselecter	Agilent	N9038A	MY46520110	6/29/2012	6/29/2013	Active Calibration
3	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	11/22/2011	11/22/2012	Active Calibration
4	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	11/22/2011	11/22/2012	Active Calibration
5	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	1/6/2012	1/6/2013	Active Calibration
6	EE 960161	26.5-40GHz LNA	Ducommun Techn	ALN-33144030	1103717-01	10/4/2011	10/4/2012	Active Calibration
7	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro	WLA622-4	123001	11/3/2011	11/3/2012	Active Calibration
8	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2013	Active Calibration
9	AA 960005	Biconical Antenna	EMCO	93110B	9601-2260	6/26/2012	6/26/2013	Active Calibration
10	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	11/15/2011	11/15/2012	Active Calibration
11	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/6/2012	1/6/2013	Active Calibration
12	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	59259	10/4/2011	10/4/2014	Active Calibration
13	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	5/16/2012	5/16/2013	Active Calibration
14	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	11/15/2011	11/15/2012	Active Calibration

Project Engineer: Aldi Quality Assurance: Shane

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2012		
RSS GEN	2010		
RSS 210	2010		

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

	PARAMETER	LSR ± Uncertainty
1	Radio Frequency, from F0	$\pm 1.3 \times 10^{-7}$
2	Total RF conducted Power	±1.38 dB
3	RF conducted power density	±1.38 dB
4	Conducted spurious emissions	±1.38 dB
5	Radiated emissions	±4.87 dB
6	Temperature	±0.64° C
7	Humidity	±2.9 %
8	DC voltage	±0.03 %
9	Low frequency voltage	±0.1 %

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