LSR a Laird Business
ACCREDITED TESTING CERT #1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

TEST REPORT # 316050 FHSS
LSR Job #: C-2391

Compliance Testing of:

Sterling-LWB

Test Date(s):
February 12th to April 18th and May 5th, 2016

Prepared For:
Attention: Josh Bablitch
LSR
W66 N220 Commerce Court
Cedarburg, WI 53012

This Test Report is issued under the Authority of:
Coty Hammerer, EMC Engineer

Signature: Coty Hammerer Date: 4/20/16

Test Report Reviewed by:	Project Engineer:
Adam Alger, Quality Systems Engineer – Test Services	Coty Hammerer, EMC Engineer.
Signature: Adam Alger Date: 4-20-16	Signature: Coty Hammerer Date: 4/20/16

TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 RSS GEN issue 4 and RSS 247 issue 1
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	Radiated Measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

1.2 – Normative References

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2016	Code of Federal Regulations - Telecommunications
RSS 247 Issue 1	2015	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI 63.10	2013	American National Standard For Testing Unlicensed Wireless devices.
FCC DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.
RSS-GEN Issue 4	2014	General Requirements and Information for the Certification of Radio Apparatus

1.3 - LS Research, LLC Test Facility

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

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:

Semi-Anechoic Chamber

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:	LSR
Address:	W66 N220 Commerce Court, Cedarburg, WI 53012
Contact Name:	Josh Bablitch

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	Sterling-LWB
Model Number:	Sterling-LWB
Serial Number:	Radiated: 29 Conducted: 26

2.3 - Associated Antenna Description

The antennas associated with the EUT are:

1. Johanson Technology high frequency ceramic chip antenna, part number 2450AT18D0100. The chip antenna has a peak gain of 1.5dBi.
2. LSR 2.4 GHz FlexPIFA antenna. Part number 001-0014 with a peak antenna gain of 2.0 dBi.
3. LSR 2.4 GHz FlexNotch antenna. Part number 001-0015 with peak antenna gain of 2.0 dBi.
4. LSR 2.4 GHz Dipole antenna. Part number 001-0010 with peak antenna gain of 2.0 dBi.

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2402 MHz to 2480MHz
RF Power in Watts	☒ Conducted Measurement ☐ EIRP
Minimum(Watts):	GFSK = 0.0063Watts EDR 2 = 0.0035Watts EDR 3 = 0.0038Watts
Maximum(Watts):	GFSK = 0.0078Watts EDR 2 = 0.0042Watts EDR 3 = 0.0044Watts
Occupied Bandwidth (99% and 20dB)	20dB (kHz): GFSK = 855.9 EDR 2 = 1333.0 EDR3 = 1262.0 99%(kHz): GFSK = 911.8 EDR 2 = 1207.5 EDR3 = 1207.2
Type of Modulation	GFSK, QPSK
Transmitter Spurious (worst case radiated) at 3 meters	42.3dBµV/m at 4803.8MHz, Peak
Stepped (Y/N)	N
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Ceramic chip antenna
Gain	1.5 dBi peak
Detachable/non-detachable	Detachable
Type	Dipole antenna
Gain	2.0 dBi peak
Detachable/non-detachable	Detachable
Type	FlexPIFA antenna
Gain	2.0 dBi peak
Detachable/non-detachable	Detachable
Type	FlexNotch antenna
Gain	2.0 dBi peak
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.247
EUT will be operated under RSS Rule Part(s)	RSS 247
Modular Filing	☒ Yes ☐ No

2.5 - Product Description

The Sterling-LWB is a multi-standard module with support for WLAN (802.11 b/g/n), and Bluetooth V2.1 and Bluetooth 4.0 & 4.1 with multiple antenna options.

Chip Antenna: Johanson Part # 2450AT18D0100 Peak Gain 1.5 dBi

U.FL Antenna port utilizes the following antenna options:

LSR 2.4 GHz Dipole Antenna 2dBi
LSR 2.4 GHz FlexPifa 2dBi
LSR 2.4 GHz FlexNotch 2dBi

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70-71° F
Humidity:	33-38%
Pressure:	726-742mmHg

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. 8.8	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247 (a)(1) 2.1049 IC : RSS 247 section 5.1	20 dB Bandwidth	Yes
FCC : 15.247(b) & 1.1310 2.1046 IC : RSS 247 section 5.4	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(d) IC : RSS 247 section 5.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(1)(iii) IC: RSS 257 Section 5.1	Carrier Frequency Separation	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 247 Section 5.1	Number of hopping channels	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 247 Section 5.1	Time of occupancy (Dwell Time)	Yes
FCC : 15.247(d), 15.205, 15.209, 2.1053 IC : RSS GEN	Transmitter Radiated Emissions in the restricted bands	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-247, Issue 1.

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 C63.10-2013. The EUT was placed on an 80cm high non-conductive pedestal below 1 GHz and 150cm above 1 GHz with absorbers lining the chamber floor, centered on a flush mounted turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit mode for final testing using power as provided by an AC to DC Lab power supply.

The applicable limits apply at a 3 meter 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 to comply with FCC Part 15.31(m).

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 200 MHz, and a Log Periodic Antenna was used to measure emissions from 200 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz while a standard gain horn antenna was used in the 18 GHz to 25 GHz range while maintaining the cone of radiation for testing above 1 GHz. The maximum radiated RF emissions between 30MHz to 25 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

The EUT was positioned in 3 orthogonal orientations.

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 a calibration laboratory accredited to ISO 17025, and are traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an EMI 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 a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 1.2 MHz) using quasi-peak detector, and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 3 MHz) for Peak measurements using a Peak detector. Average measurements were performed using an average detector using 1MHz bandwidth (video bandwidth of 3MHz)

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-247, Issue 1, for an 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 and reported data

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), radiated emissions that fall within the restricted band described in 15.205(c), 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):
To convert 100 µV/m to dBµV/m,

dBµV/m = 20 $\log_{10}$ (100)= 40 dBµV/m (from 30-88 MHz)

5.6 - Radiated Emissions Test Data Chart

Manufacturer:	LSR					
Date(s) of Test:	February 12th – April 18th 2016					
Project Engineer(s):	Coty Hammerer					
Test Engineer(s):	Coty Hammerer/Kimberly Bay					
Voltage:	3.6VDC					
Operation Mode:	Continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 70-71° F Relative Humidity: 33-38%					
EUT Power:		Single Phase 120VAC		3 Phase ___VAC		
		Battery	X	Other: Bench DC supply		
EUT Placement:	X	80cm non-conductive pedestal	X	150cm non-conductive pedestal		
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

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Quasi-Peak Reading (dBµV/m)	Average Reading (dBµV/m)	Peak Limit (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Average Limit (dBµV/m)	Peak Margin (dB)	Quasi-Peak Margin (dB)	Average Margin (dB)	Antenna Polarity	Antenna	Mode	EUT orientation
76.40	1.00	296.80	N/A	29.8	N/A	N/A	40.0	N/A	N/A	10.2	N/A	V	Dipole	GFSK	Vertical
4804.00	1.00	0.00	42.0	N/A	36.9	74.0	N?A	54.0	32.0	N/A	17.1	H	FlexPIFA	GFSK	Vertical
4804.00	3.20	353.00	41.6	N/A	36.3	74.0	N/A	54.0	32.4	N/A	17.7	V	Chip	GFSK	Vertical
4804.00	2.60	295.80	42.0	N/A	37.3	74.0	N/A	54.0	32.0	N/A	16.7	H	Chip	GFSK	Vertical
4804.00	2.10	188.50	41.7	N/A	35.9	74.0	N/A	54.0	32.3	N/A	18.1	V	Chip	GFSK	Side
4804.00	1.80	333.50	42.3	N/A	38.0	74.0	N/A	54.0	31.7	N/A	16.0	H	Chip	GFSK	Side
7440.00	1.00	53.50	40.0	N/A	33.3	74.0	N/A	54.0	34.0	N/A	20.7	H	Chip	GFSK	Flat

Notes:

1. Chip antenna showed highest emissions above 1 GHz.
2. Refer to exhibit 5.5 on explanation of how data is reported.

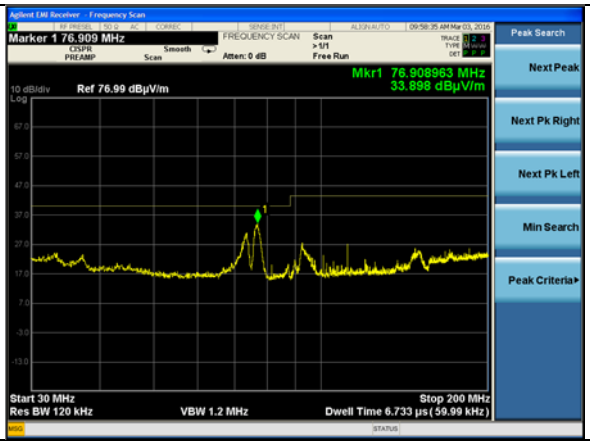
5.7 – Screen Captures.

The screen captures below are those using the Peak detector of the analyzer. In addition, the screen captures presented are those which were deemed to be an appropriate representation of the spectrum scan.

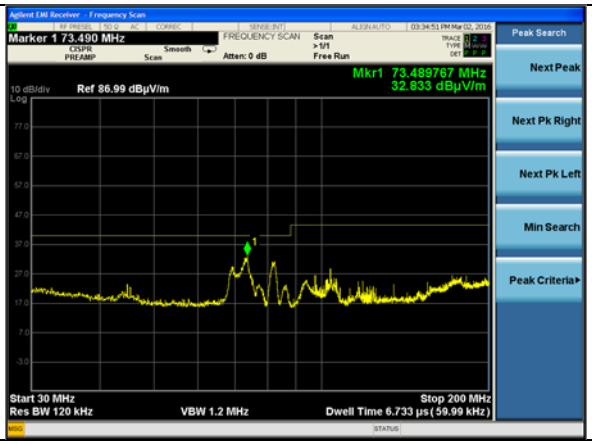
30 to 200 MHz, 3m distance.

Horizontal Transmitter enabled

Horizontal Transmitter disabled

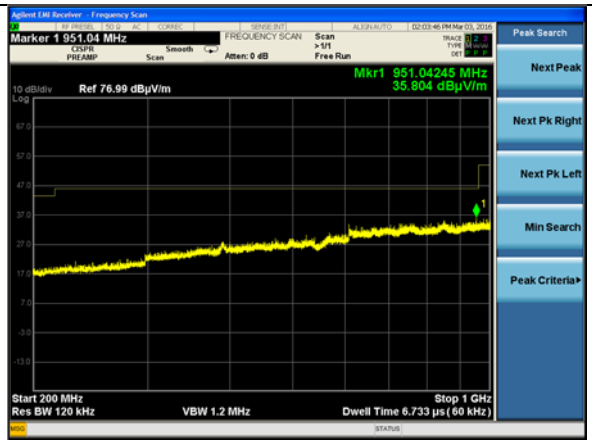


Vertical Transmitter enabled

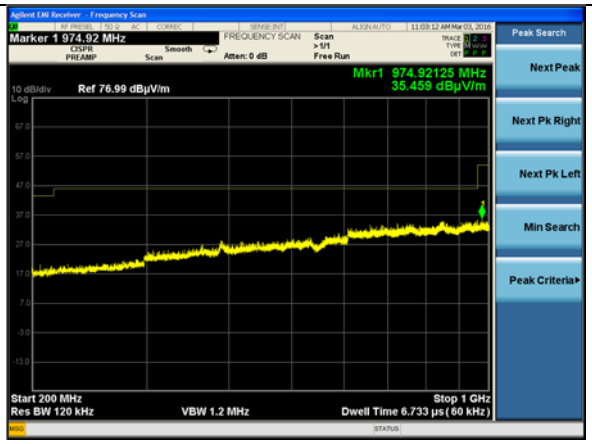


Vertical Transmitter disabled

200 to 1000 MHz, 3m distance.



Horizontal Transmitter enabled

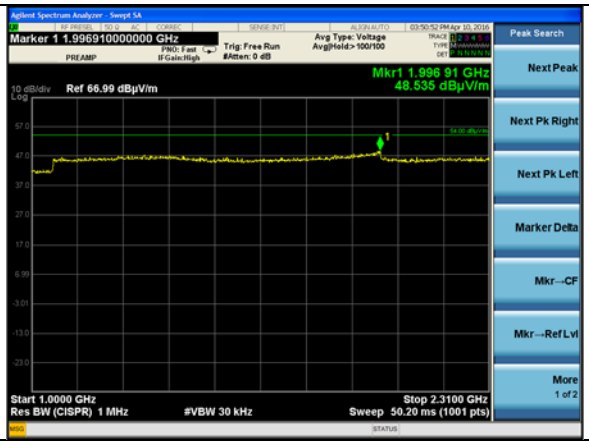


Horizontal Transmitter disabled

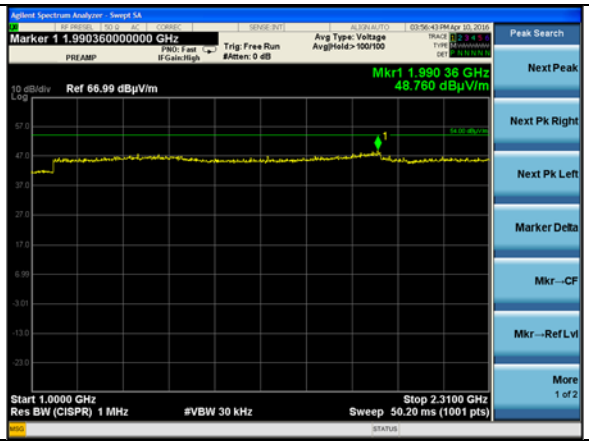
Vertical Transmitter enabled

Vertical Transmitter disabled

1000 to 2400 MHz, 3m distance.



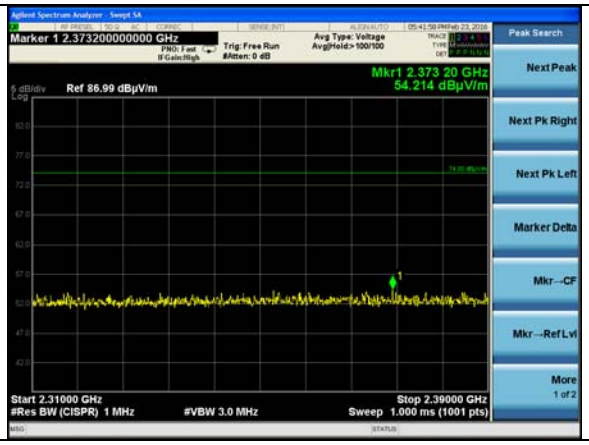
Horizontal



Vertical

2310 to 2390 MHz, 3m distance.

Average



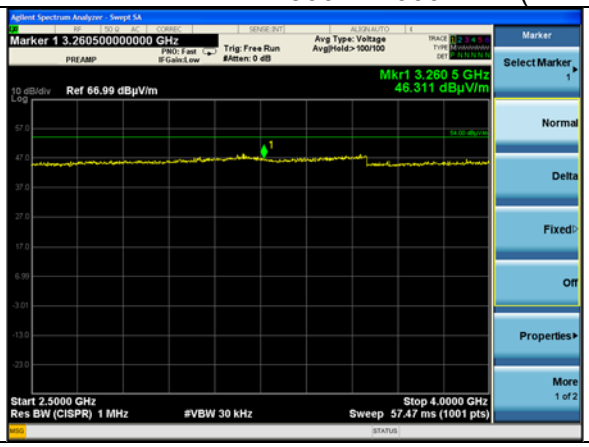
Peak

Notes:

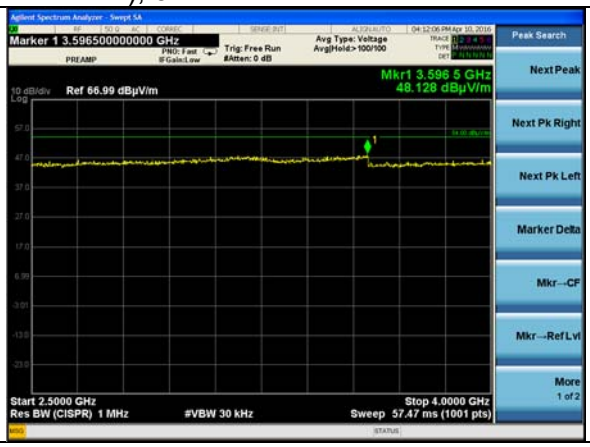
1. The plot above taken when EUT was in basic rate mode and represents worst case. EDR2 and EDR3 modes were tested and found to be lower in emission.
2. Table below shows points on the plot of the maximum emission:

Peak Frequency (MHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Average Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2733.2	54.214	74	19.786	2364.64	42.042	54	11.958

2500 to 4000 MHz (Reduced bandwidth), 3m distance.



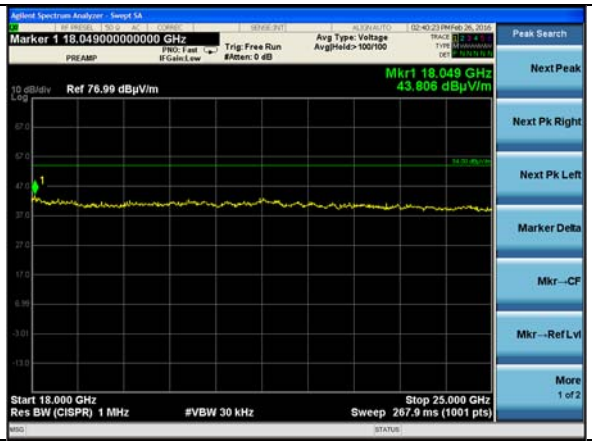
Horizontal



Vertical

4000 to 25000 MHz.

4000 to 18000 MHz



18000 to 25000 MHz (reduced bandwidth)

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

EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

6.1 Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The power supply was then plugged into a 50Ω (ohm), Line Impedance Stabilization Network (LISN). An "off the shelf" AC-DC adapter provided a 3.3VDC supply 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 an EMI receiver System. The Com-Power LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

6.2 Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. 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.

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 were performed at an IEC/ISO 17025 accredited calibration laboratory, traceable to the SI standard. All cables are calibrated and checked periodically for conformance. The emissions are measured on the EMI System, 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 Part 15.207 and RSS GEN 7.2.4 for Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

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:	LSR					
Date(s) of Test:	3/14/16					
Project Engineer:	Coty Hammerer					
Test Engineer:	Coty Hammerer					
Voltage:	120VAC (120VAC to 3.3 VDC)					
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

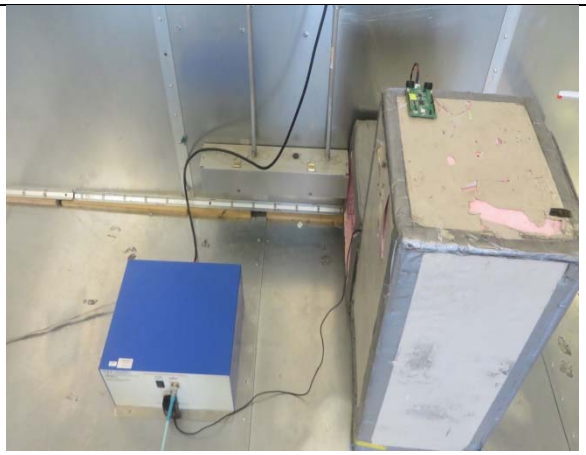
3.3VDC

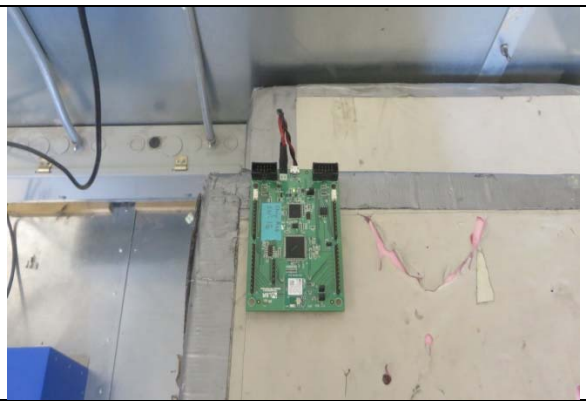
Line	Frequency (MHz)	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Notes
1	0.15	40.50	66.00	25.50	28.30	56.00	27.70	Tx
1	0.63	33.60	56.00	22.40	25.50	46.00	20.50	Tx
1	0.16	39.80	65.42	25.62	28.70	55.42	26.72	Tx
2	0.62	34.00	56.00	22.00	24.90	46.00	21.10	Tx
2	0.16	33.00	65.73	32.73	19.90	55.73	35.83	Tx
2	0.16	34.70	65.47	30.77	21.60	55.47	33.87	Tx

Notes:

1) The emissions listed are characteristic of the power supply used and not that of the transmitter. Changing transmit channels did not change the emissions.

6.7 Test Setup Photo(s) – Conducted Emissions Test





6.8 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.

3.3VDC

Line 1

Line 2

EXHIBIT 7. OCCUPIED BANDWIDTH

7.1 - Limits

For an FHSS system operating in the 2400 to 2483.5 MHz band, there are no limits for 20dB bandwidth.

7.2 - Method of Measurements

Industry Canada (IC RSS GEN 4.6.1) requires the measurement of the 99% bandwidth while CFR 47 part 15.247 requires the measurement of the 20dB bandwidth. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to 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 there by 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. A bandwidth measurement function that is built into the spectrum analyzer was used to measure the bandwidths.

Measurement procedure: FCC DA 00-705

7.3 - Test Data

Packet Type	Channel	Frequency (MHz)	20dB EBW (kHz)	99% EBW (kHz)
GFSK	0	2402	855.9	903.8
	39	2440	854.9	908.7
	79	2480	854.3	911.5
EDR2	0	2402	1324.0	1204.6
	39	2440	1331.0	1206.4
	79	2480	1330.0	1207.5
EDR3	0	2402	1261.0	1206.6
	39	2440	1259.0	1206.6
	79	2480	1262.0	1207.2

7.4 – Screen Captures

A. GFSK

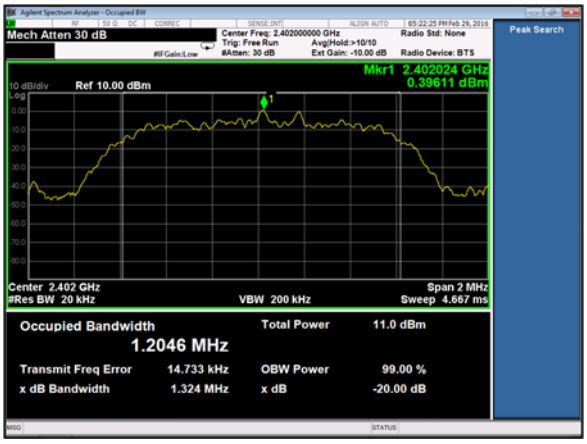
Channel 2402MHz

Channel 2440MHz

Channel 2480MHz

B. EDR2

Channel 2402MHz

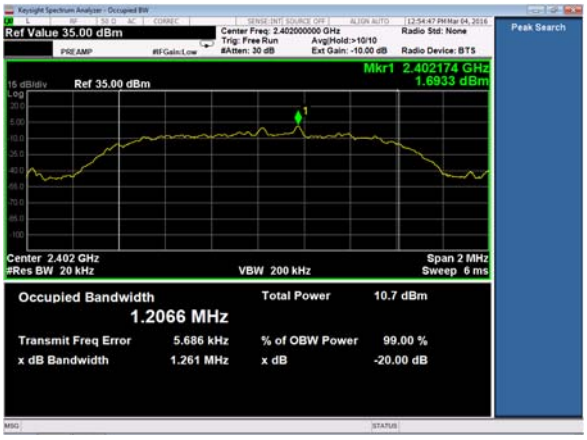


Channel 2440MHz

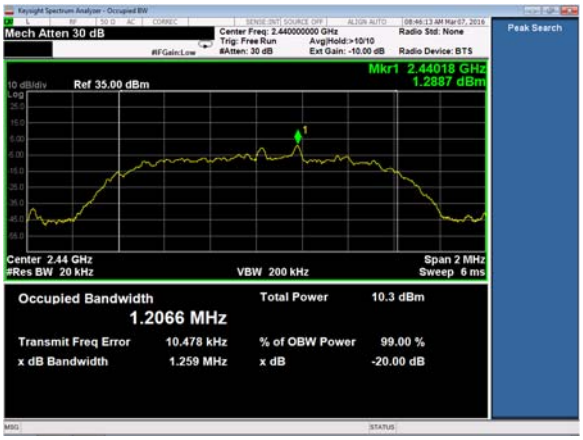
Channel 2480MHz

C. EDR3

Channel 2402MHz



Channel 2440MHz



Channel 2480MHz

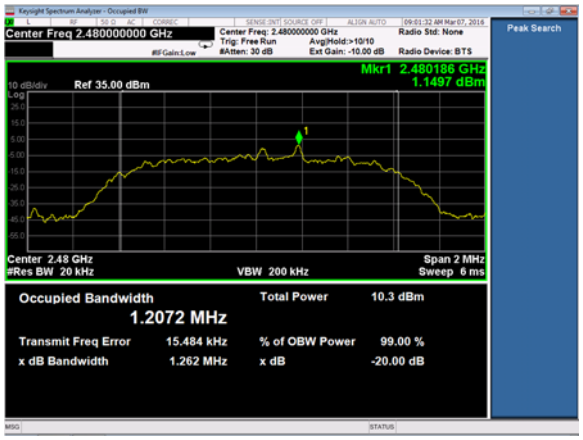


EXHIBIT 8. BAND EDGE MEASUREMENTS

8.1 - Method of Measurements

FCC 15.247 requires a measurement of spurious emission levels at the restricted band to be compliant to the general emissions limit, in particular at the Band-Edges where the intentional radiator operates. 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 radiated and conducted. The conducted measurement of band-edge was performed to satisfy FCC 15.247(d). The radiated measurements were performed to satisfy the conditions of 15.205 restricted bands.

For radiated measurements, the EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 1.2 MHz) using quasi-peak detector, and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 3 MHz) for Peak measurements using a Peak detector. Average measurement was performed using a Peak detector with 1MHz resolution bandwidth and 10Hz video bandwidth.

Conducted measurements of the spurious emission were performed with a measurement bandwidth of 100kHz while radiated measurements were performed with a measurement bandwidth of 1MHz.

For both conducted and radiated measurements, correction factors and the cable loss factors were entered into the EMI Receiver database. **As a result, the plots taken from the EMI Receiver accounts for all applicable correction factor as well as cable loss, and can therefore be entered into the database as a corrected meter reading.**

Measurement procedure:

1. Conducted measurement: FCC DA 00-705
2. Radiated measurements: ANSI C63.10

8.2. Band-Edge captures.

Radiated Band-edge restricted band (2483.5 to 2500 MHz):

Data:

A. GFSK (Basic rate)

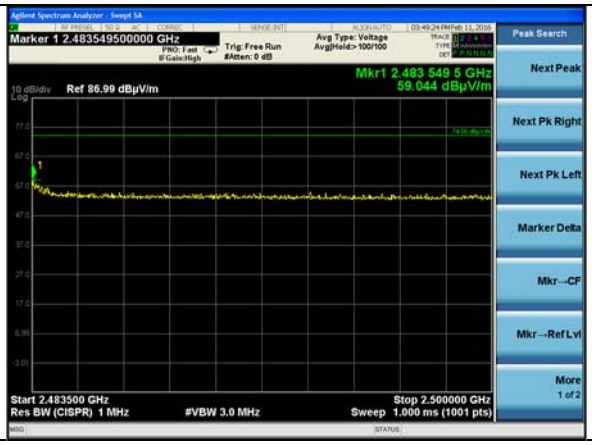
Peak Frequency (MHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Average Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2483.5	59.0	74.0	15.0	2483.5	42.8	54.0	11.2

B. EDR2 (2MBPS)

Peak Frequency (MHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Average Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2483.8	54.8	74.0	19.2	2483.5	42.3	54.0	11.7

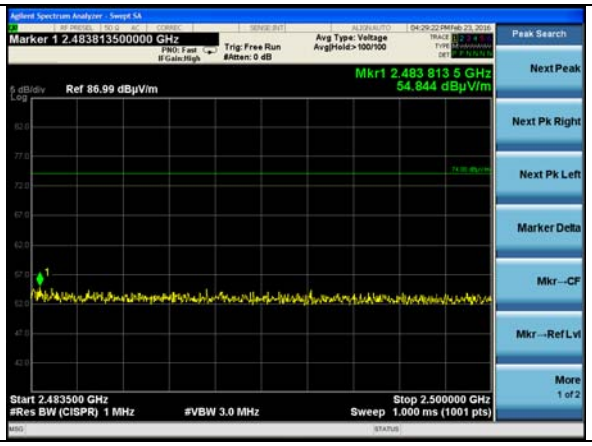
C. EDR3 (3MBPS)

Peak Frequency (MHz)	Peak (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Average Frequency (MHz)	Average (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2488.2	54.8	74.0	19.2	2483.5	42.3	54.0	11.7



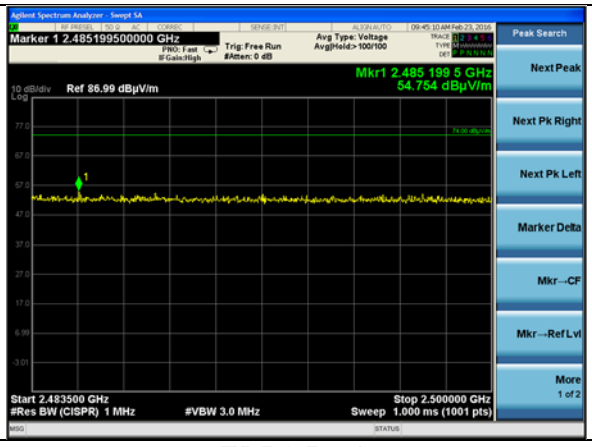
GFSK Peak

GFSK Average

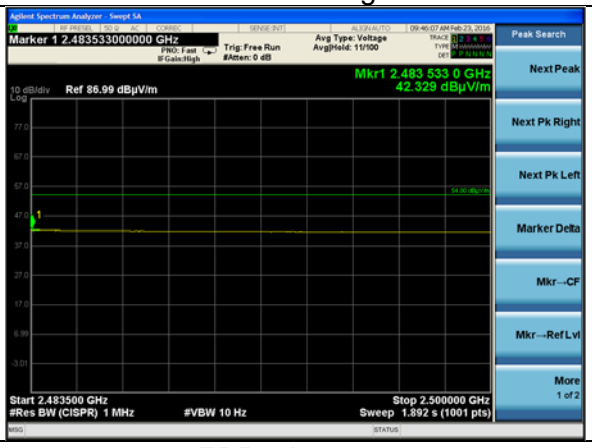


EDR2 Peak

EDR2 Average



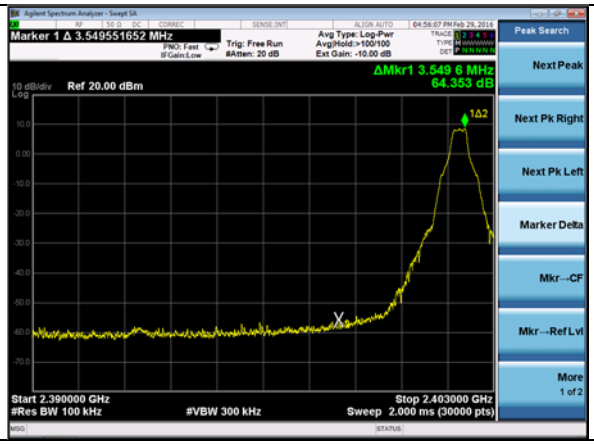
EDR3 Peak



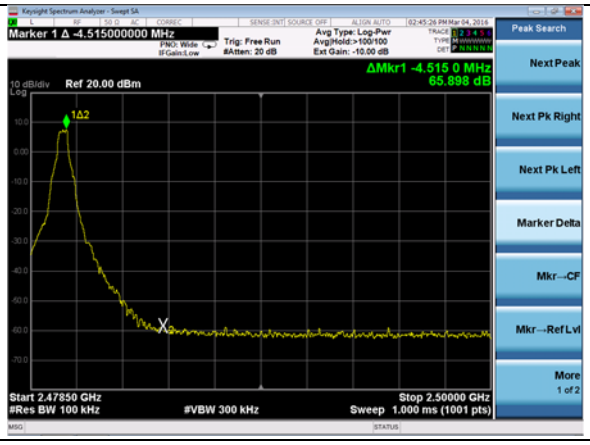
EDR3 Average

Conducted Band-edge:

GFSK

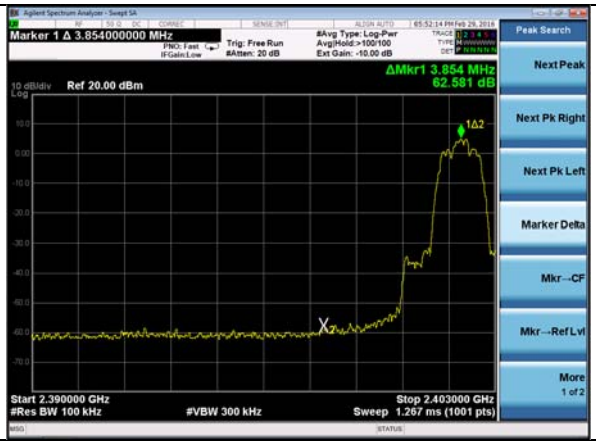


Lower band edge

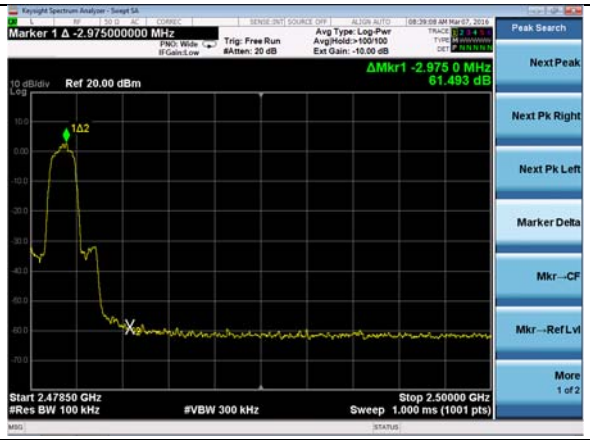


Upper band edge

EDR2

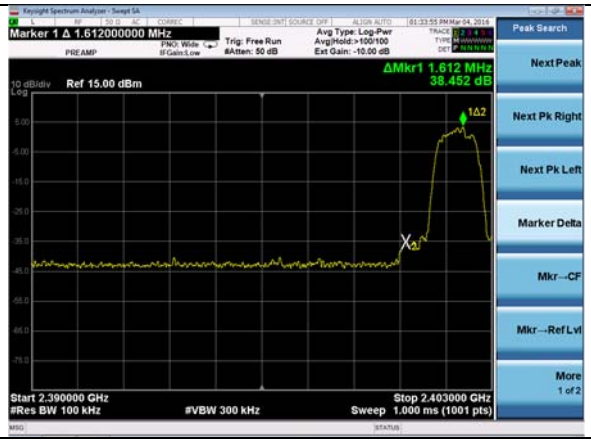


Lower band edge

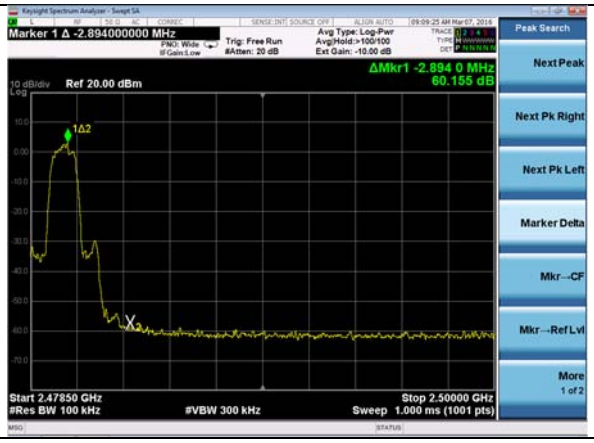


Upper band edge

EDR3

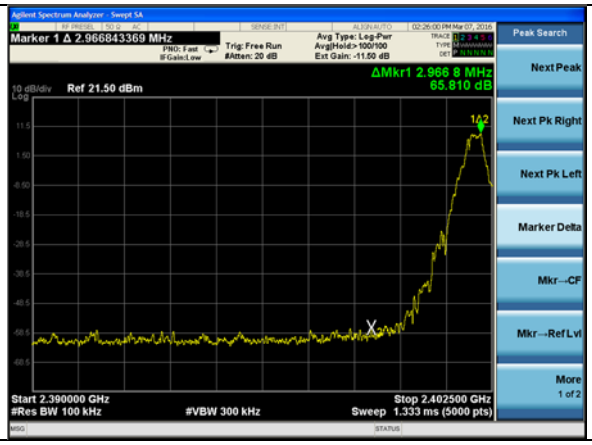


Lower band edge

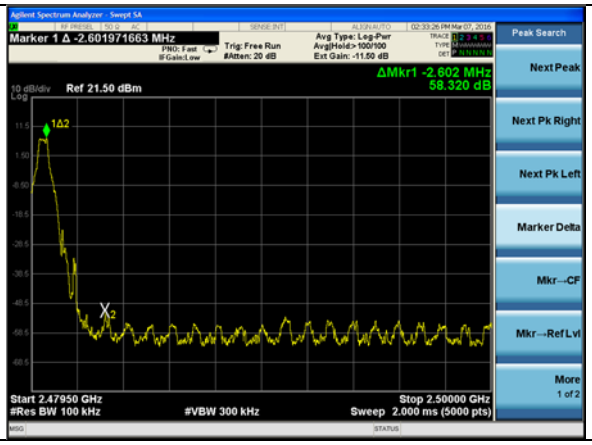


Upper band edge

Hopping mode:

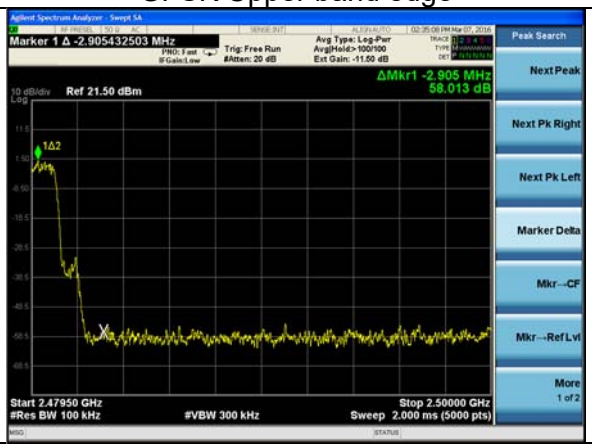


GFSK Lower band edge



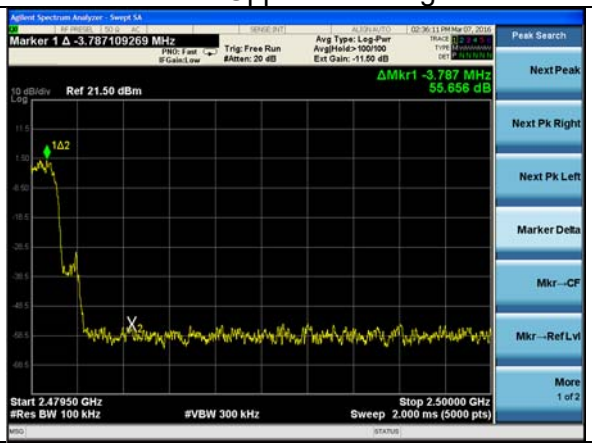
GFSK Upper band edge

EDR2 Lower band edge



EDR2 Upper band edge

EDR3 Lower band edge



EDR3 Upper band edge

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

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by 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 the appropriate resolution bandwidth, with measurements from a peak detector presented in the chart below.

Measurement procedure: FCC DA 00-705

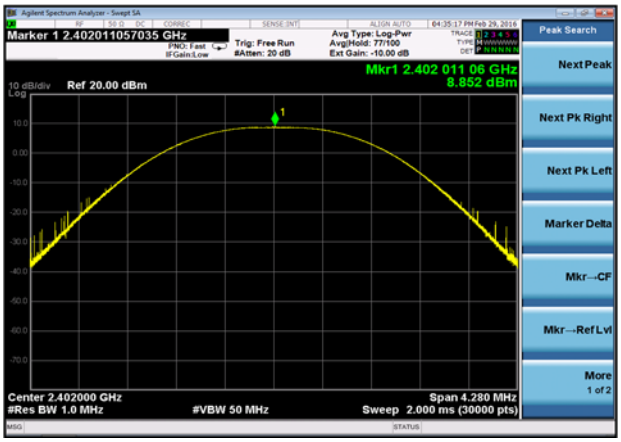
9.2 - Test Data

Packet Type	Channel	Frequency (MHz)	Output Power (dBm)	Output power limit (dBm)	Margin (dB)
GFSK	0	2402	8.9	21.0	12.1
	39	2440	8.5	21.0	12.5
	79	2480	8.0	21.0	13.0
EDR2	0	2402	6.2	21.0	14.8
	39	2440	5.6	21.0	15.4
	79	2480	5.4	21.0	15.6
EDR3	0	2402	6.4	21.0	14.6
	39	2440	5.9	21.0	15.1
	79	2480	5.8	21.0	15.2

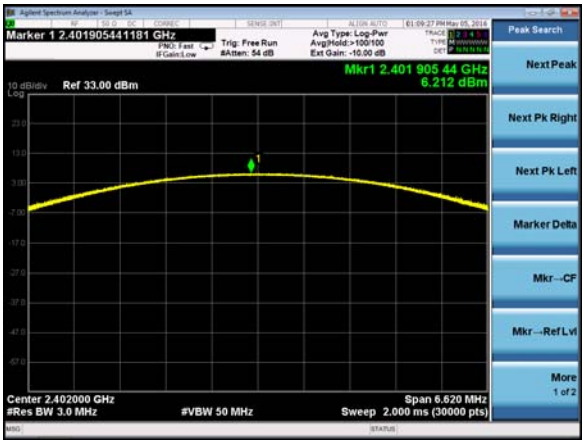
9.3 – Screen Captures

Low Channel (2402 MHz)

GFSK



EDR2

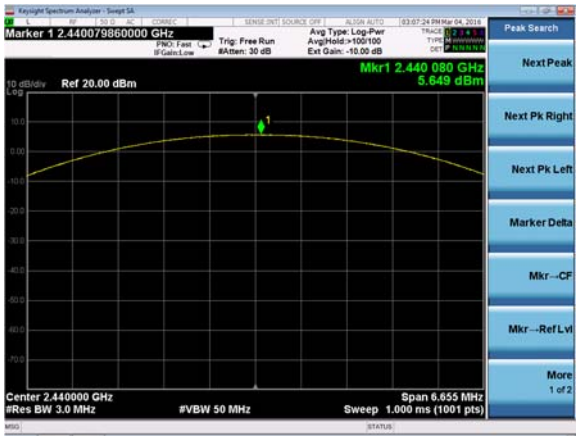


EDR3

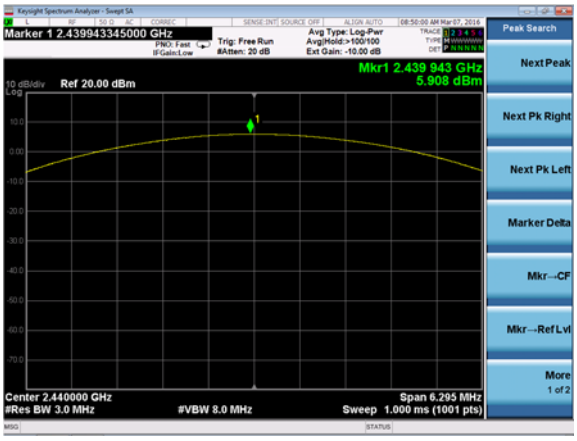
Middle Channel (2440 MHz)

GFSK

EDR2



EDR3



High Channel (2480 MHz)

GFSK

EDR2

EDR3

EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

10.1 - Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

10.2 – Conducted Harmonic And Spurious RF Measurements

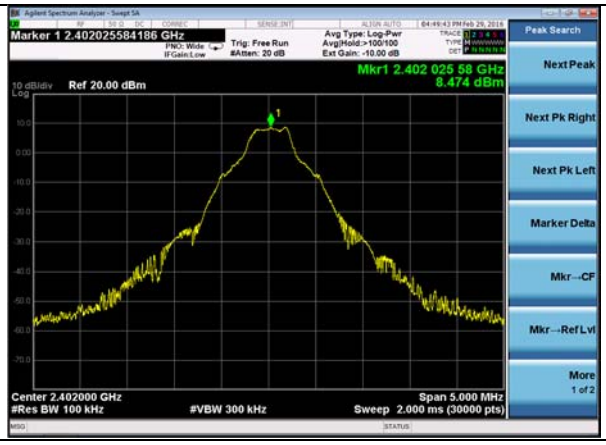
FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along 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 procedure: FCC DA 00-705

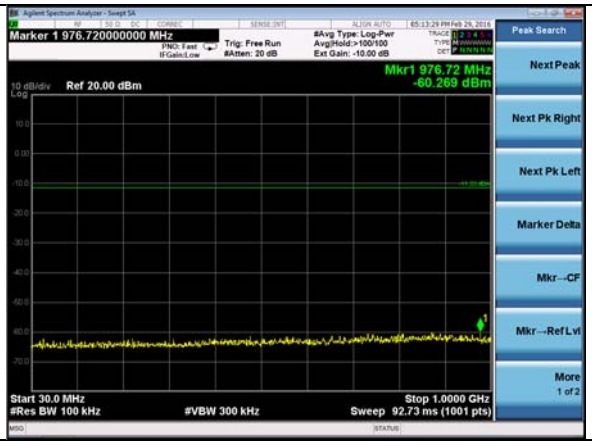
10.3 - Test Data

Note: Testing was performed on all modes but only data on GFSK (Basic rate) presented below representing the worst case among the modes

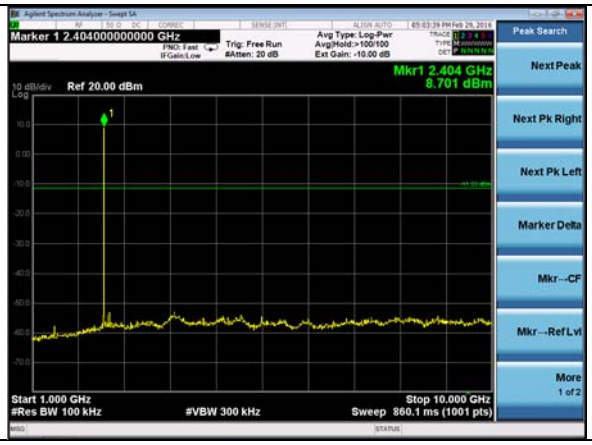
A. Low Channel



Fundamental



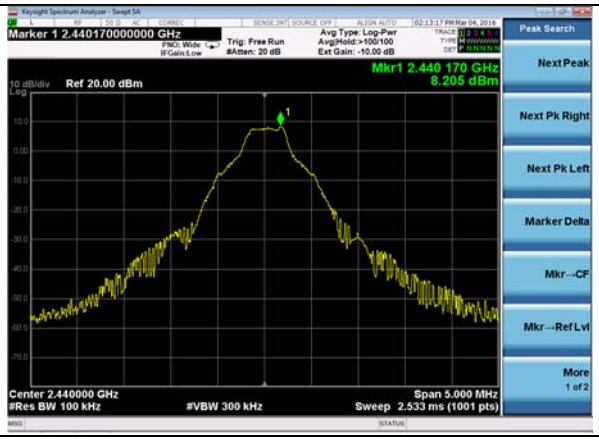
30 to 1000MHz



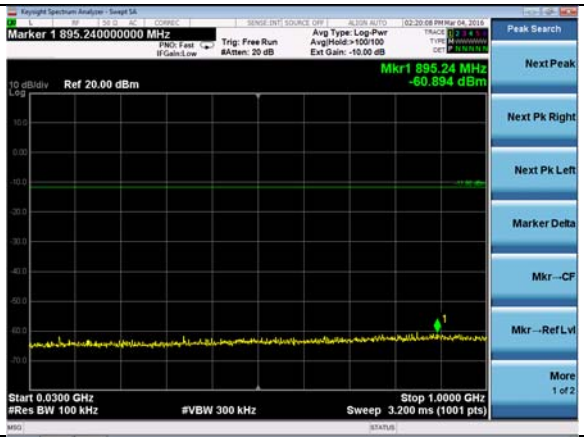
1000 to 10000 MHz

10000 to 25000

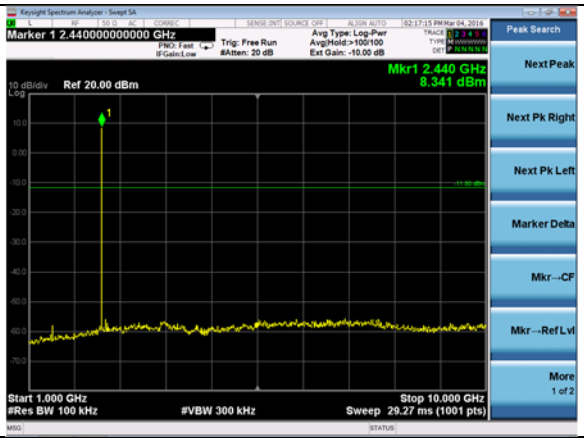
B. Middle Channel



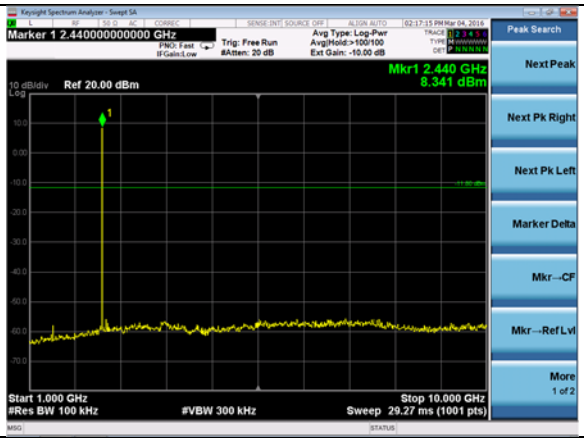
Fundamental



30 to 1000MHz



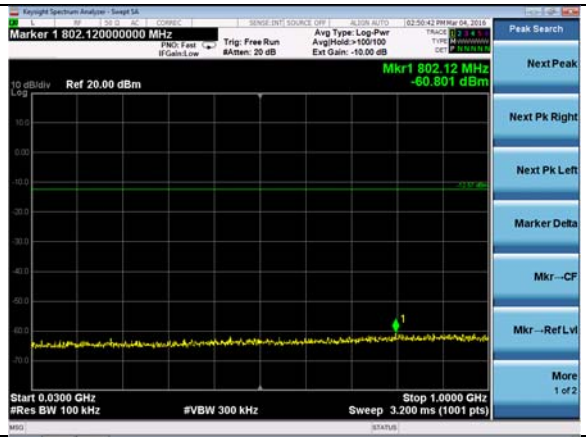
1000 to 10000 MHz



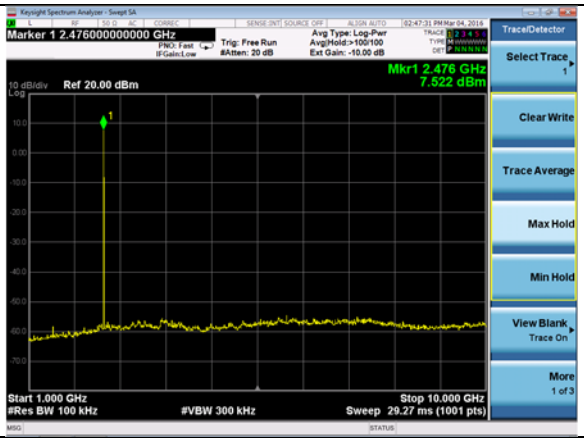
10000 to 25000

C. High Channel

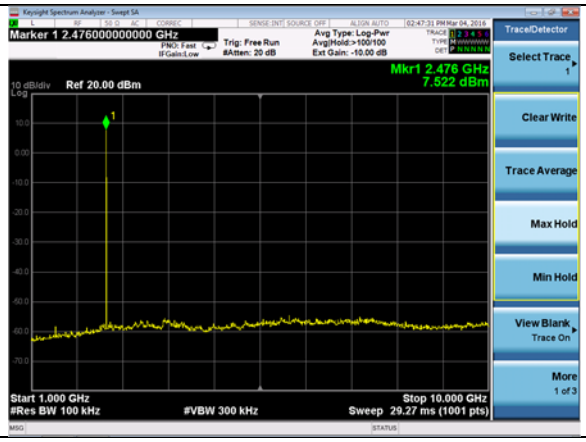
Fundamental



30 to 1000MHz



1000 to 10000 MHz



10000 to 25000

EXHIBIT 11. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

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 power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied from the minimum and maximum operating voltages because ±10% of the nominal is outside the operating voltages of the module.

BT	3.0 VDC	3.3 VDC	3.6 VDC	
Channel	Frequency (Hz)	Frequency (Hz)	Frequency (Hz)	Frequency Drift (Hz)
2402	2402012348	2402012326	2402012253	95
2440	2440016742	2440016691	2440016676	66
2480	2480021597	2480021567	2480021521	76

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

A spectrum analyzer was used with a resolution bandwidth of 1% of the span to measure the channel separation of the EUT.

Measurement procedure: FCC DA 00-705

The channel separation measured for this device **1000.0 kHz** which is greater than 2/3 of the 20dB bandwidth. The maximum 20dB bandwidth of the device, as reported in the previous section is 1331 kHz, therefore 2/3 of the 20dB bandwidth = 887.3 kHz. The following plots describe this spacing, and also establish the channel separation and plan.

This EUT also satisfies the minimum number of hopping channels which is 15.

Span	Number of channels
2400 to 2441 MHz	39.0
2441 to 2483 MHz	40.0

Total Number of channels	79.0

12.1 - Screen Captures

Channel Separation

Number of channels

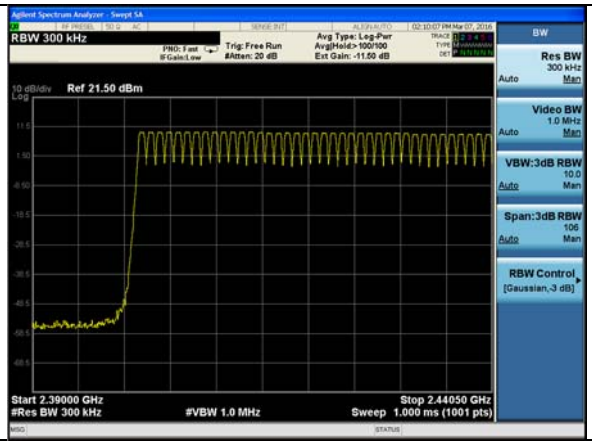
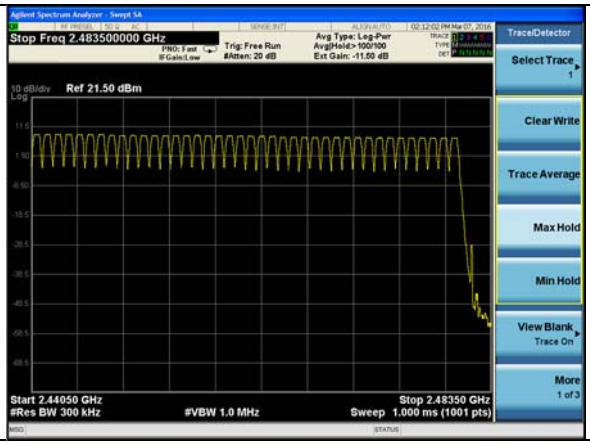
	
2390 – 2441 MHz	2441 – 2483.5 MHz

EXHIBIT 13. CHANNEL OCCUPANCY.

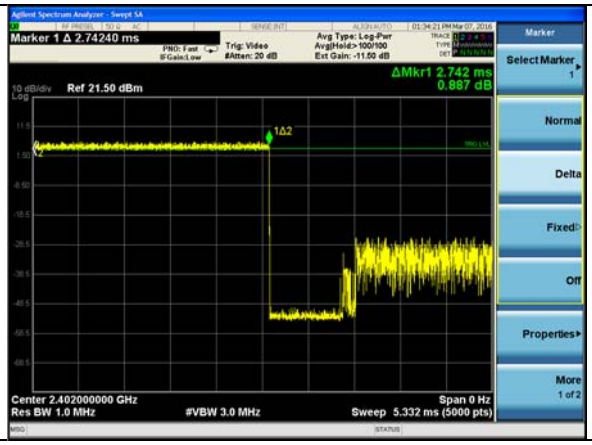
Measurement procedure: FCC DA 00-705

Part 15.247(a)(1)(i) requires an average 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. The longest time a single transmission will occur on a single channel is **2.742 ms**. The number of occurrences in a **10 seconds** window is **37.** In a 31.6 seconds window, there will be **116.92** occurrences. Therefore the total time occupancy in a 31.6 seconds window is

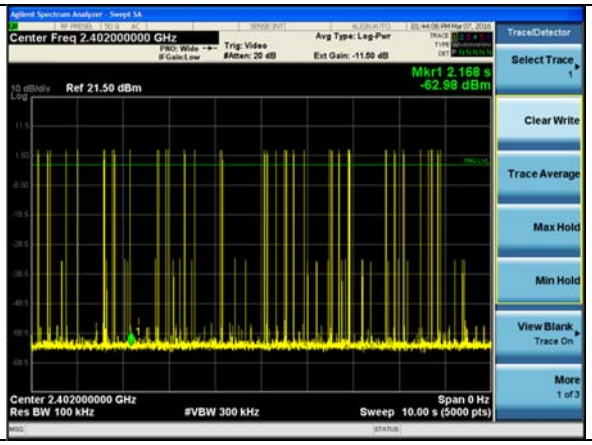
116.92 x 2.742ms = **320.6ms**

13.1 Time occupancy captures.

(The captures shown are from EDR3 mode which is worst case, lowest channel)



Single transmission



Maximum Occupancy in 10s

EXHIBIT 14. EQUAL CHANNEL USAGE

The transceiver implemented in the EUT is a Bluetooth core specification V2.1 + EDR hence satisfies this requirement.

APPENDIX A – Test Equipment List

LSR
a Laird Business

Date: 12-Feb-2016 Type Test: Radiated Measurements Job #: C-2391

Prepared By: Coty Hammerer Customer: LSR Quote #: 316050

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960153	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-04	4/15/2015	4/15/2016	Calibration Due
2	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	40201429	2/4/2016	2/4/2017	Active Calibration
3	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	2/4/2016	2/4/2017	Active Calibration
4	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	Verification	Verification	System
5	AA 960162	EM Series Cable	MegaPhase	EM26-S1S1-120	12024301 001	6/30/2015	6/30/2016	Active Calibration
6	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/6/2015	5/6/2016	Active Calibration
7	EE 960077	DC Power Supply	GW Instek	GPS-3030DD	EJ810521	Verification	Verification	System
8	AA 960005	Biconical Antenna	EMCO	93110B	9601-2280	1/14/2016	1/14/2017	Active Calibration
9	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	3/31/2016	3/31/2017	Active Calibration
10	Rental	Horn Antenna 18-40 GHz	AH Systems, Inc	SAS-574	193	11/30/2015	11/30/2016	Active Calibration

LSR
a Laird Business

Date: 10-Feb-2016 Type Test: Conducted Measurements Job #: C-2391

Prepared By: Coty Hammerer Customer: LSR Quote #: 316050

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/24/2017	Active Calibration
2	EE 960077	DC Power Supply	GW Instek	GPS-3030DD	EJ810521	Verification	Verification	System
3	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	Verification	Verification	System
4	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/26/2015	6/26/2017	Active Calibration
5	RE 16002	PXA Spectrum Analyzer 26.5 GHz	Keysight	N9030A	MY54490691	2/23/2016	2/23/2017	Active Calibration

LSR
a Laird Business

Date: 14-Apr-2016 Type Test: Conducted Emissions Job #: C-2391

Prepared By: Coty Hammerer Customer: LSR Quote #: 316050

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960162	LISN - 15A	COM-POWER	LI-215A	191969	7/24/2015	7/24/2016	Active Calibration
2	EE 960077	DC Power Supply	GW Instek	GPS-3030DD	EJ810521	Verification	Verification	System
3	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/24/2017	Active Calibration

Project Engineer: Coty Hammerer Quality Assurance: Dane Dick

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2014		
ANSI C63.10	2013		
FCC 47 CFR, Parts 0-15	2016		
FCC Public Notice DA 00-705	2000		
RSS GEN	2014		
RSS 247	2015		

APPENDIX C - Uncertainty Statement

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*

APPENDIX D –Bluetooth and WLAN Coexistence

The BCM4343W implements an advance Enhanced Collaborative algorithms and hardware mechanism, allowing for a collaborative WLAN and Bluetooth coexistence. Support is provided for platforms that share a single antenna between Bluetooth and WLAN.

.