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TEST REPORT # 315001
LSR Job #: C-2140

Compliance Testing of:
BLE-Beacon

Test Date(s):
February 6-18, 2015

Prepared For:
Danlaw
Attn: George Gablen
41131 Vicenti Court
Novi, MI 48375

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Industry Canada (IC) RSS 247
Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz

This Test Report is issued under the Authority of:

Signature: Thomas T. Smith Date: 7/30/2015

Test Report Reviewed by:

Signature: Thomas T. Smith Date:7/30/2015

Tested by: Peter Feilen, EMC Engineer

Signature: Peter Feilen Date: 7/28/15

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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	Title
47 CFR, Parts 0-15 (FCC)	Code of Federal Regulations - Telecommunications
RSS 210 Annex 8	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
KDB 558074 D01 DTS Meas Guidance v02	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247

1.3 LS Research, LLC TEST FACILITY

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

LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted. Accreditation status can be verified at A2LA’s web site: www.a2la.org.

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

List of Facilities Located at LS Research, LLC:

- Compact Chamber
- Semi-Anechoic Chamber
- Open Area Test Site (OATS)

1.5 TEST EQUIPMENT UTILIZED

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated in accordance with A2LA standards.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**Danlaw Inc.**
Address:	**41131 Vicenti Court, Novi, MI 48375**
Contact Name:	**Gheorghe Galben**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	BLE-Beacon ID Card
Model Number:	DL-BLE-10
Serial Number:	Engineering Sample

2.3 ASSOCIATED ANTENNA DESCRIPTION

Integral PCB antenna.

2.4 EUT'S TECHNICAL SPECIFICATIONS

EUT Frequency Range (in MHz)	2402-2480 MHz
EIRP in Watts	0.00037 W
Conducted Output Power (in dBm)	-4.3 dBm
Occupied Bandwidth (99% BW)	1.01 MHz
Type of Modulation	GFSK
Emission Designator	1M01D1X
Transmitter Spurious (worst case) at 3 meters	40.8 dBuV/m @ 3m
Receiver Spurious (worst case) at 3 meters	32.6 dBuV/m @ 3m
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Transceiver Model #	Nordic nRF51822-QFAA
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Trace
Gain (in dBi)	0 dBi
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	RSS-247
Modular Filing	☐ Yes ☒ No
Portable or Mobile?	Portable

2.5 PRODUCT DESCRIPTION

The Danlaw Low-profile BLE Beacon is a small credit card sized device that is meant to be carried by a user in a wallet, in a purse or on a keychain. The Danlaw Low-profile BLE Beacon communicates with Danlaw OBDII Wireless Datalogger products via Bluetooth Low Energy (Bluetooth Smart) to pass the vehicle driver or occupant information.

The Danlaw Low-profile BLE Beacon consists of a plastic enclosure, battery holder for 3 CR2412 batteries and a wireless flexible printed circuit assembly.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	65-70℉
Humidity:	30-60% R.H.

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	N/A
FCC : 15.247(a)(2) IC : RSS 210 A8.2(a)	6 dB Bandwidth of a Digital Modulation System	Yes
IC : RSS GEN section 4.6.1	99% Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(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(d) IC : RSS 210 A8.2(b)	Transmitted Power Spectral Density of a Digital Modulation System	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
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC).		

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 8 (2010) for a Digital Spread Spectrum (DTS) Transmitter.

If some emissions are seen to be within 3 dB of their respective limits:
As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 3-meter diameter turntable inside a 3-meter, FCC listed, semi-anechoic chamber. The EUT was operated in and final testing was performed using constant modulated transmit mode. The unit has the capability to operate on 3 channels, controllable via a cellular phone application for test purposes.

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: low (2402 MHz), middle (2440 MHz) and high (2480 MHz) to comply with FCC Part 15.31(m). The channels and operating modes were changed using a cellular phone application for test purposes.

5.2 Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. From 18 GHz to 25 GHz, the EUT was measured using a standard gain Horn Antenna and pre-amplifier.

The battery voltage was checked frequently, and the batteries were replaced as necessary.

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

5.3 Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an Agilent E4445A/N9039A EMI System. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 1.2 MHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 3 MHz for peak measurements, 10Hz for average measurements). From 4 GHz to 18 GHz, a spectrum analyzer and EMCO horn antenna with low noise amplifier were used. From 18 GHz to 25 GHz, a spectrum analyzer as well as a standard gain horn with preamp were used.

Test Equipment List

Please see Appendix A

5.4 Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-247 for a DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3) and RSS 210 A8.4 is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d) and RSS 210 A8.2(b), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c) for FCC and section 2.2,2.6 and 2.7 of RSS 210 for IC.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS 210 section 2.7.

Frequency (MHz)	3 m Limit μV/m	3 m Limit (dBμV/m)	1 m Limit (dBμV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
> 960	500	54.0	63.5

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

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

> 960 MHz
500μV/m or 54.0 dB/μV/m at 3 meters
54.0 + 9.5 = 63.5 dB/μV/m at 1 meter

Sample Calculation using correction factors from the device

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

Generic example of reported data at 200 MHz:

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

5.6 RADIATED EMISSIONS TEST DATA CHART

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

Manufacturer:	Danlaw					
Date(s) of Test:	2/13/15					
Test Engineer:	Peter Feilen					
Voltage:	3 VDC					
Operation Mode:	Continuous modulated transmit					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
	X	Battery		Other:		
EUT Placement:	X	80cm non-conductive table		10cm Spacers		
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS		
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:	X	Peak	X	Quasi-Peak	X	Average

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

30-1000 MHz:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation	Notes
183.8	1.00	0	24.6	43.5	18.9	V	V	2
299.0	1.00	0	31.4	46.0	14.6	V	V	2
297.5	1.00	0	31.4	46.0	14.6	H	V	2
999.5	1.00	0	37.9	54.0	16.1	H	V	2
999.1	1.00	0	36.5	54.0	17.5	H	V	2
998.9	1.00	0	36.3	54.0	17.7	V	V	2

>1GHz:

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	1.64	311	49.3	40.8	54	13.2	Horizontal	Side
4804	1.37	81	49.2	39.9	54	14.1	Vertical	Side
4960	1.52	41	48.0	39.3	54	14.7	Horizontal	Side

Notes:

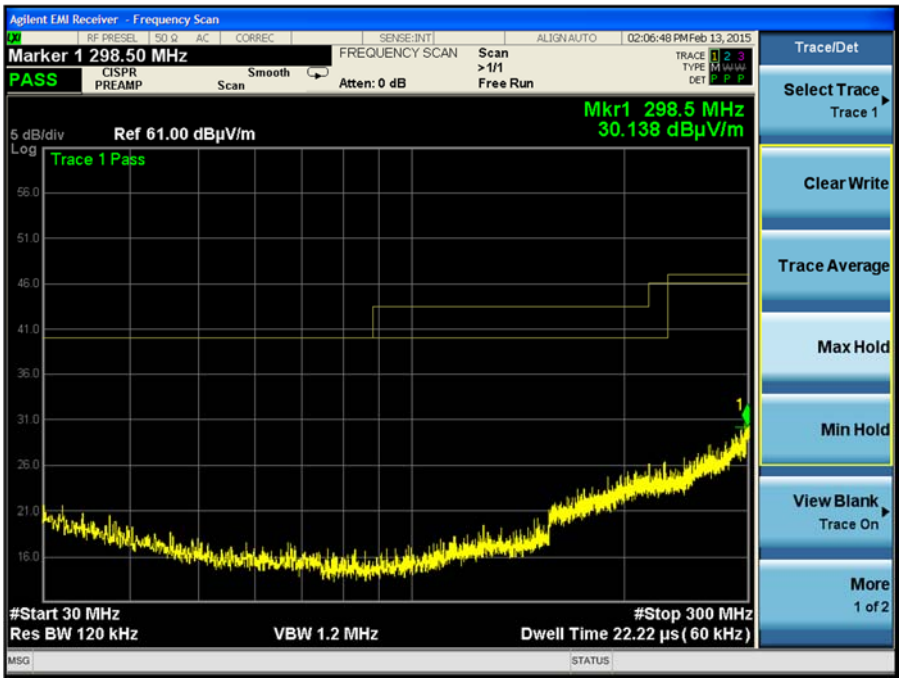
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.

2) Measurement at receiver system noise floor.

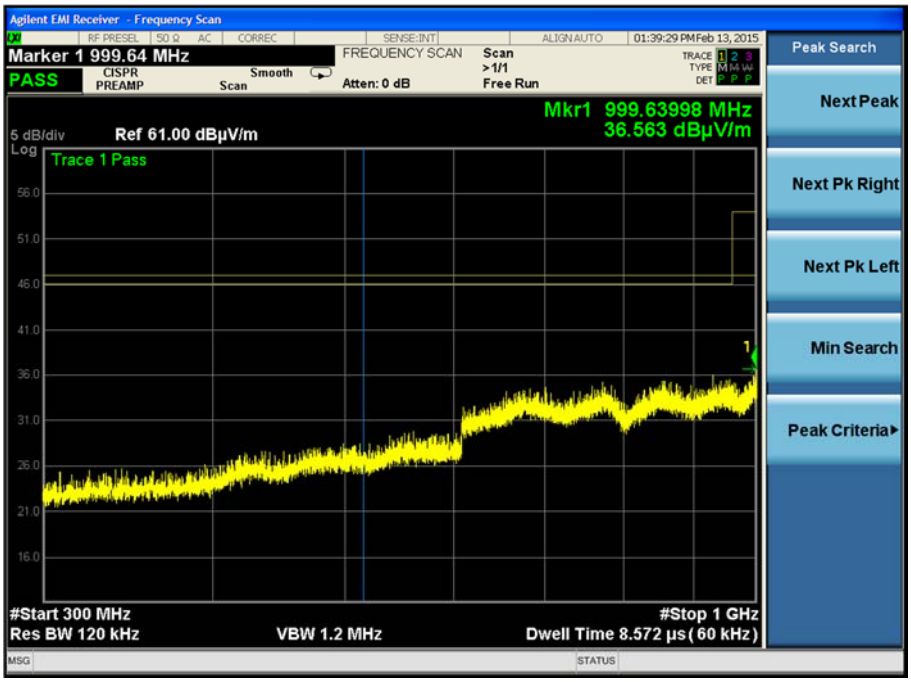
5.7 Screen Captures - Radiated Emissions Test

These screen captures represent Peak Emissions. A Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz; an Average detector function is utilized when measuring frequencies above 1 GHz.

Channel 19, Antenna Vertically Polarized, 30-300 MHz, at 3m

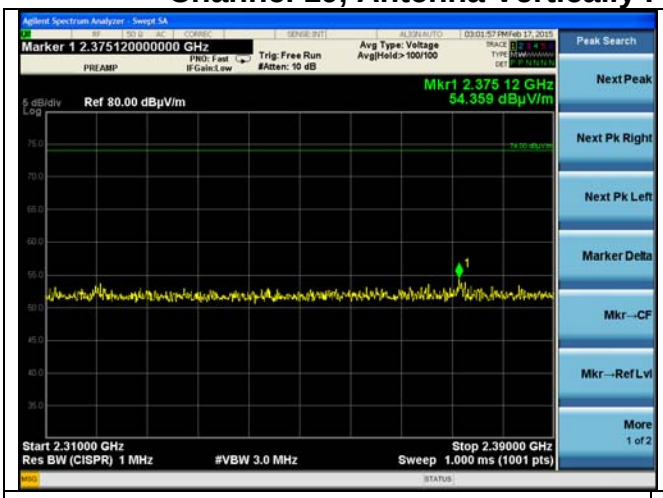


Channel 19, Antenna Vertically Polarized, 300-1000 MHz, at 3m

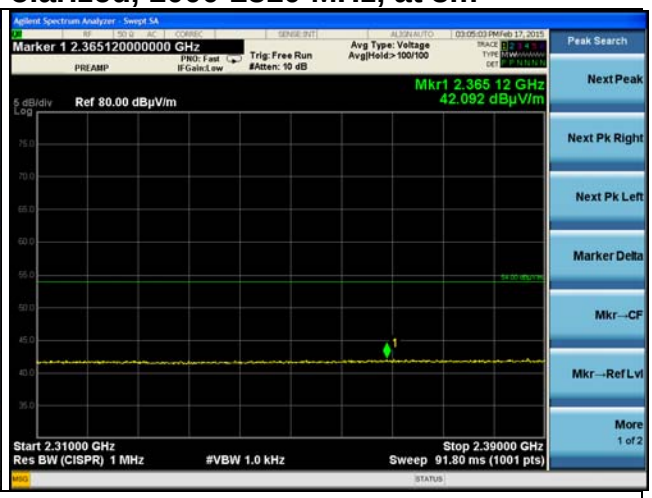


Screen Captures - Radiated Emissions Testing *(continued)*

Channel 19, Antenna Vertically Polarized, 1000-2310 MHz, at 3m



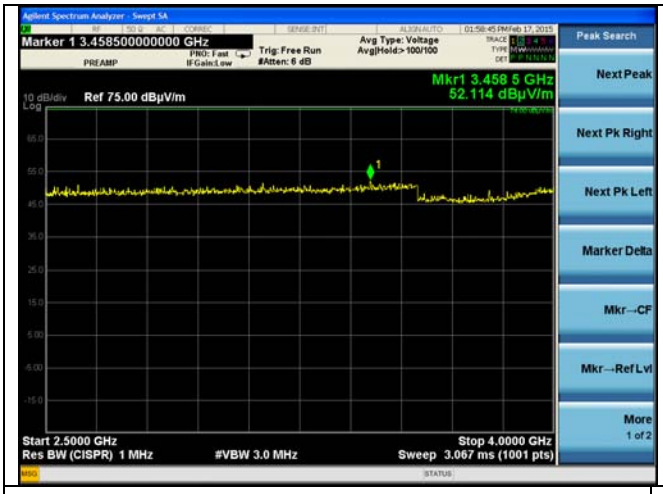
Peak



Average

2390-2400 MHz is represented in Section 8, Bandedge Measurements
2483.5-2500 MHz is represented in Section 8, Bandedge Measurements

Channel 19, Antenna Vertically Polarized, 2500-4000 MHz, at 3m



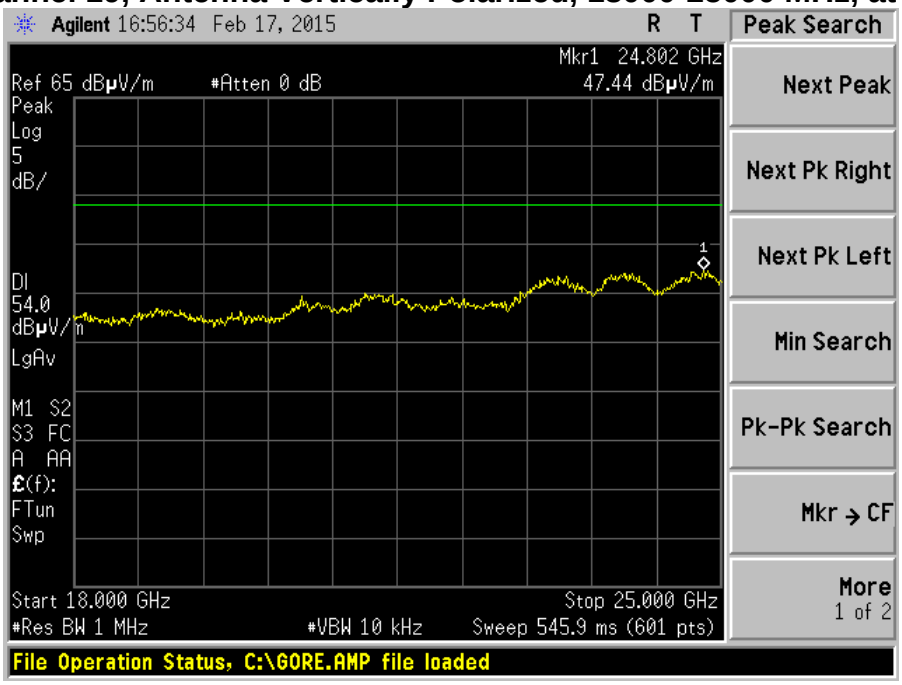
Peak

Average

Channel 19, Antenna Horizontally Polarized, 4000-18000 MHz, at 1m

Reduced video bandwidth shown demonstrating spurious emissions are not buried in the system noise floor

Channel 19, Antenna Vertically Polarized, 18000-25000 MHz, at 3m



5.9 Receive Mode Testing

The EUT was placed in continuous receive mode and the radiated spurious emissions were measured and compared to the respective limits.

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

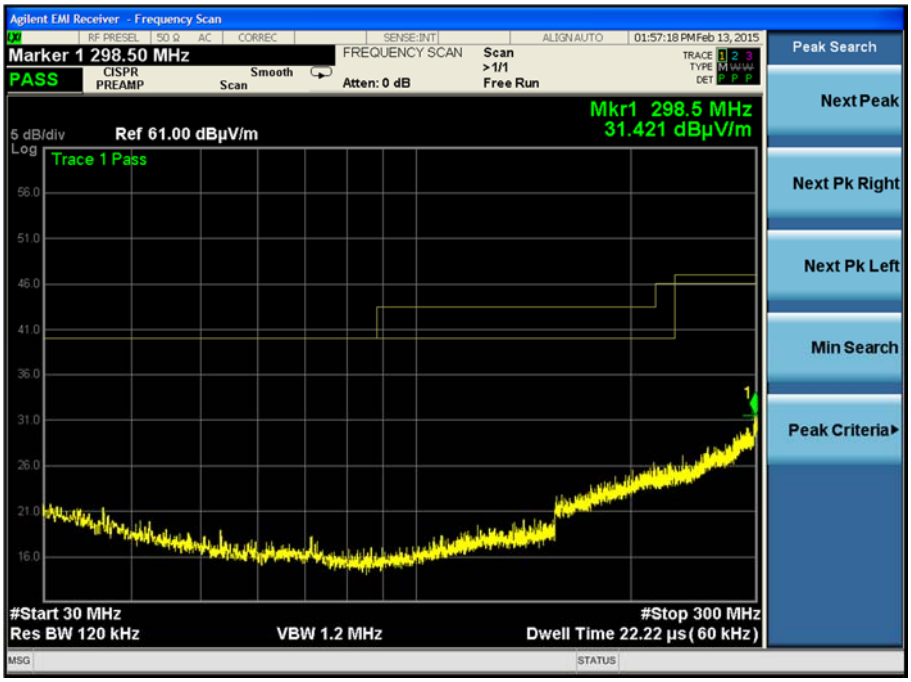
Measurement data and screen captures from the receive tests are presented below:

Frequency (MHz)	Antenna	EUT	Height (m)	Azimuth (°)	Peak (dBµV/m)	Peak limit (dBµV/m)	Average (dBµV/m)	Average limit (dBµV/m)	Peak margin (dB)	Average margin (dB)	Notes
4800.0	H	V	1.00	0	39.8	74.0	29.3	54.0	34.2	24.7	1.0
7206.0	V	V	1.00	0	40.7	74.0	31.9	54.0	33.3	22.1	1.0
9608.0	H	V	1.00	0	42.1	74.0	32.6	54.0	31.9	21.5	1.0
2402.0	H	V	1.00	0	38.6	74.0	28.7	54.0	35.4	25.3	1.0

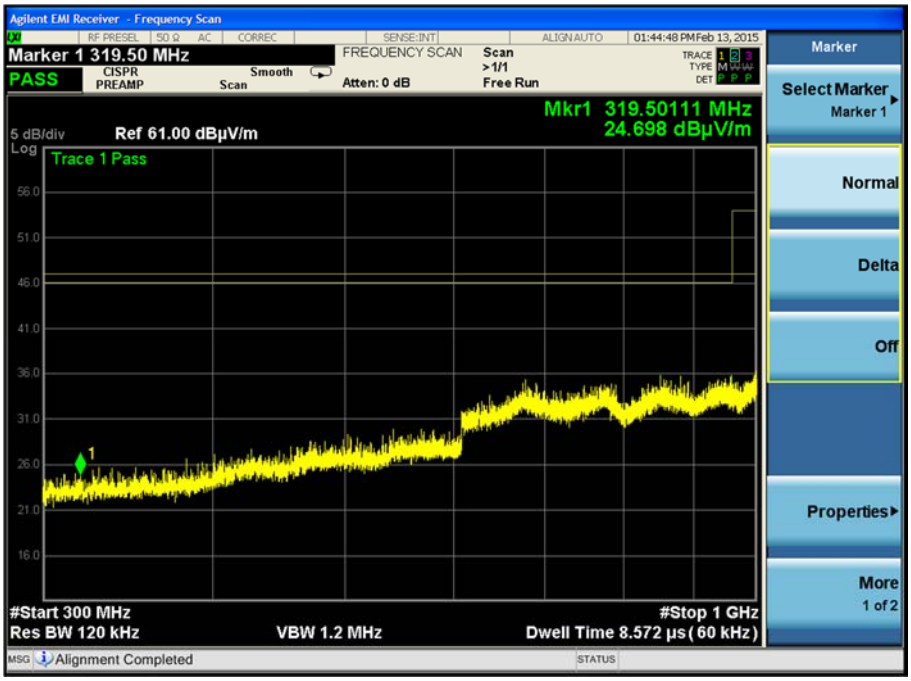
Screen Captures - Radiated Emissions Testing – Receive Mode

These screen captures represent Peak Emissions. A Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz; an Average detector function is utilized when measuring frequencies above 1 GHz.

Channel 19, Antenna Horizontally Polarized

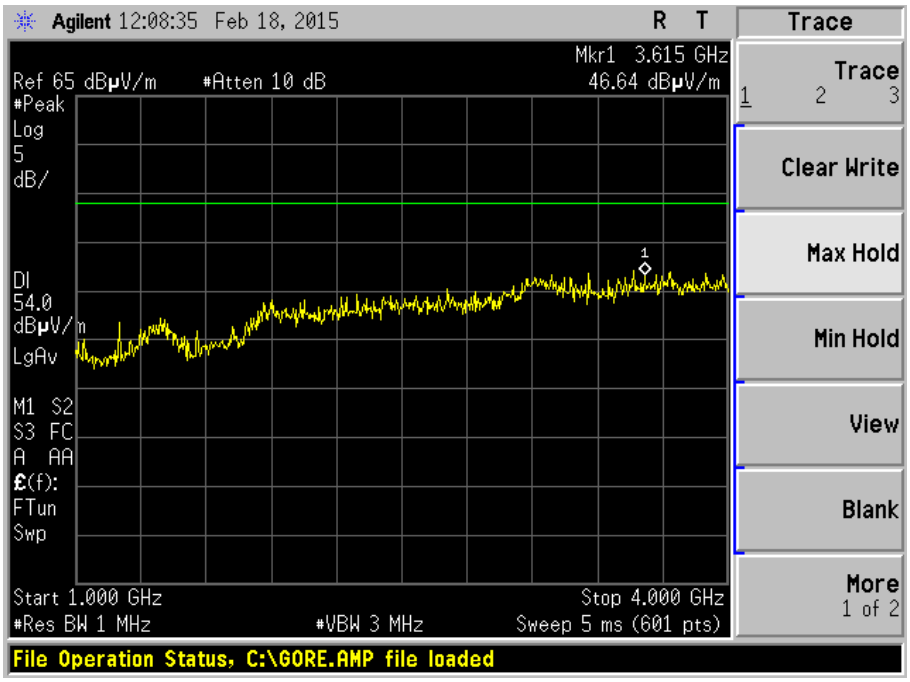


Channel 19, Antenna Vertically Polarized

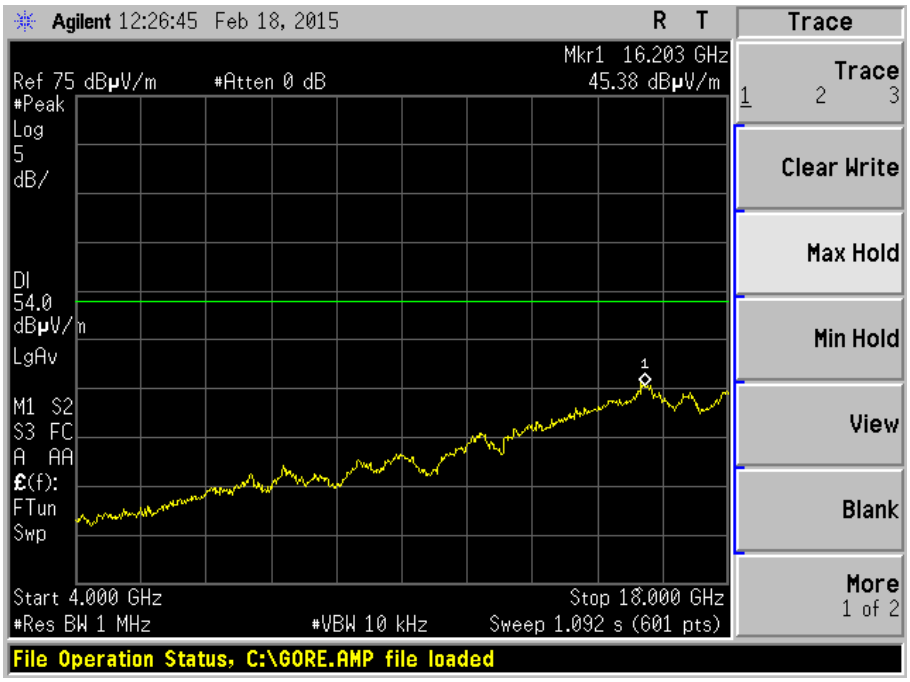


Screen Captures - Radiated Emissions Testing – Receive Mode *(continued)*

Channel 19, Antenna Horizontally Polarized



Channel 19, Antenna Vertically Polarized



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

Channel 19, Antenna Horizontally Polarized

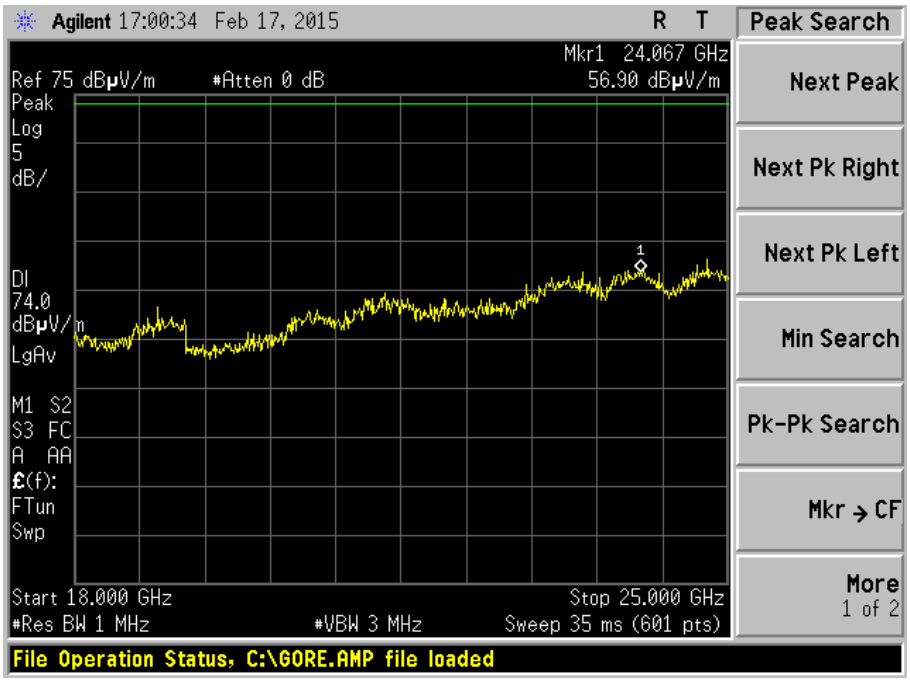


EXHIBIT 6.CONDUCTED EMISSIONS TEST, AC POWER LINE:

Not applicable. Battery operated

EXHIBIT 7. OCCUPIED BANDWIDTH:

7.1 Limits

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

7.2 Method of Measurements

KDB 558074 D01 DTS Meas Guidance v03r02 section 8.1 option 2 for Digital Transmission Systems operating under 15.247 and ANSI C63.10.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 100 kHz RBW and VBW=300 kHz.

The bandwidth requirement found in FCC Part 15.247(a)(2) and RSS 247 requires a minimum 6 dBc occupied bandwidth of 500 kHz. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The attenuator were added on the analyzer as gain offset settings, thereby allowing direct measurements, without the need for any further corrections. Cable corrections were made through the correction factor loaded on the spectrum analyzer hard drive, there by allowing no need for further correction. Data is presented in the chart below.

From this data, the closest measurement (6 dB bandwidth) when compared to the specified limit, is 632 kHz, which is above the minimum of 500 kHz.

7.3 Test Equipment List

Please see Appendix A

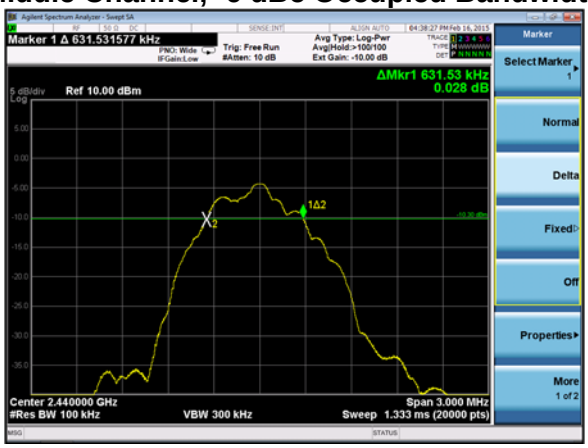
7.4 Test Data

Modulation	Channel	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	6dB Bandwidth minimum limit (MHz)
GFSK	2402	0.6453	1.004	0.5
	2440	0.6315	1.005	0.5
	2480	0.6495	1.004	0.5

7.5 Screen Captures - OCCUPIED BANDWIDTH

Low Channel, -6 dBc Occupied Bandwidth

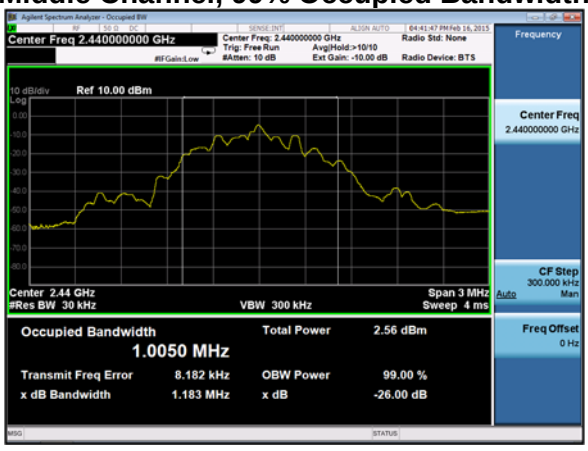
Middle Channel, -6 dBc Occupied Bandwidth



High Channel, -6 dBc Occupied Bandwidth

Low Channel, 99% Occupied Bandwidth

Middle Channel, 99% Occupied Bandwidth



High Channel, 99% Occupied Bandwidth

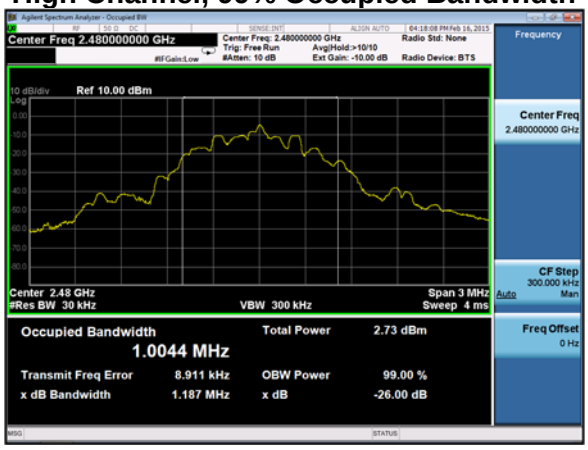


EXHIBIT 8. Band-Edge Measurements

8.1 Test Description

FCC 15.209(b) and 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in tables 2 and 3 of the same standard and also to the limits in the applicable annex.

8.2 Method of Measurements

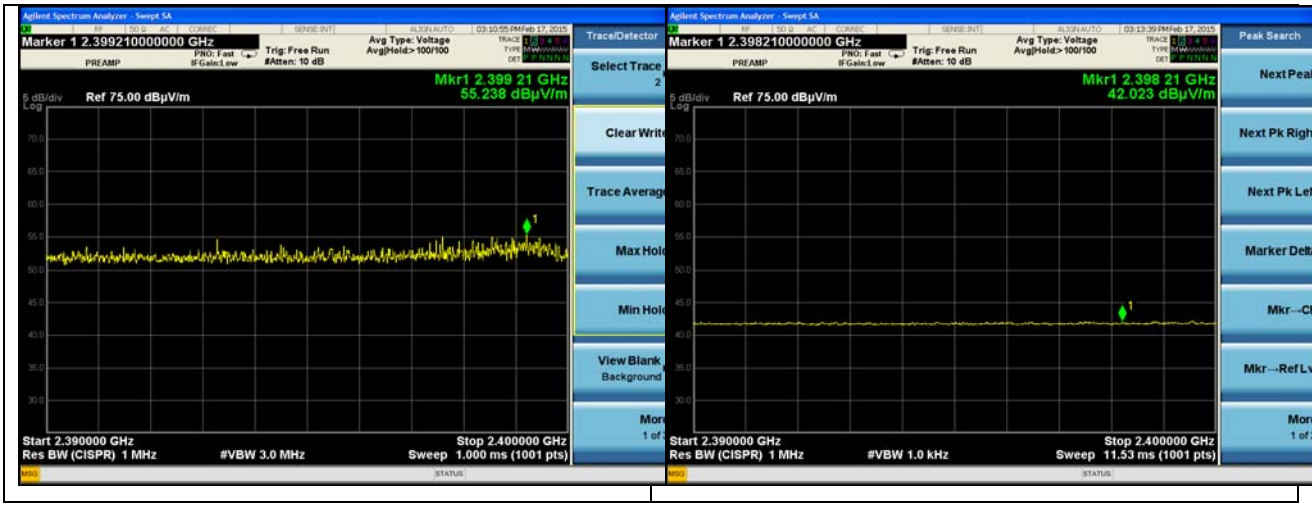
The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

For a 2.4 GHz Transmitter:

The Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

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

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Screen Capture Demonstrating Compliance at the Higher Band-Edge

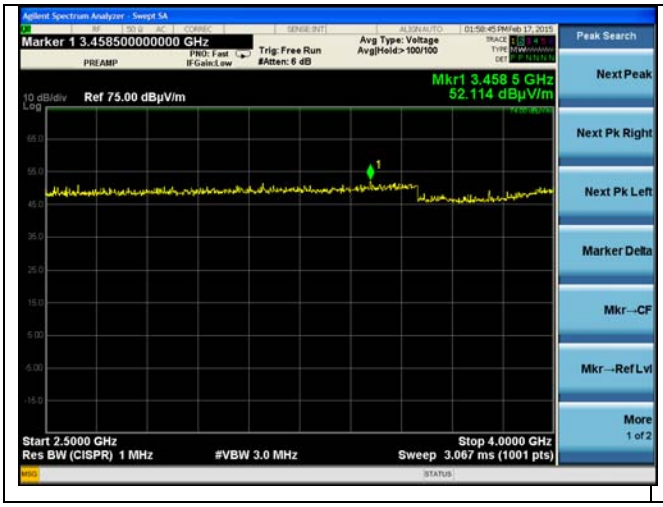


EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

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, thereby 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 modulated data. The spectrum analyzer was used with resolution and video bandwidths set to 1 MHz, and a span of 3 MHz, with measurements from a peak detector presented in the chart below.

9.2 Test Equipment List

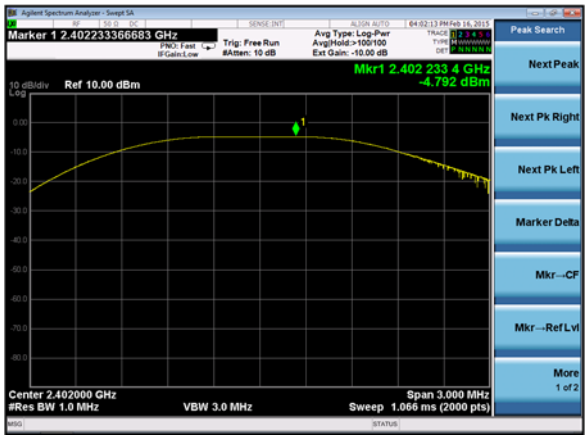
Please see Appendix A

9.3 Test Data

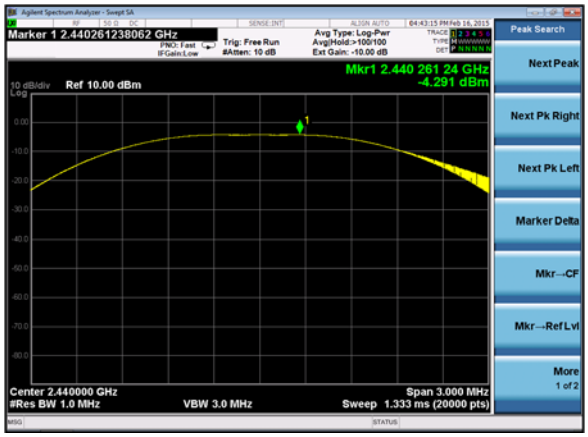
Modulation	Channel	Maximum Peak Conducted Power (dBm)	Power Limit (dBm)	Power margin (dB)
GFSK	2402	-4.8	30.0	34.8
	2440	-4.3	30.0	34.3
	2480	-4.4	30.0	34.4

9.4 Screen Captures – Power Output (Conducted)

Low Channel



Middle Channel



High Channel

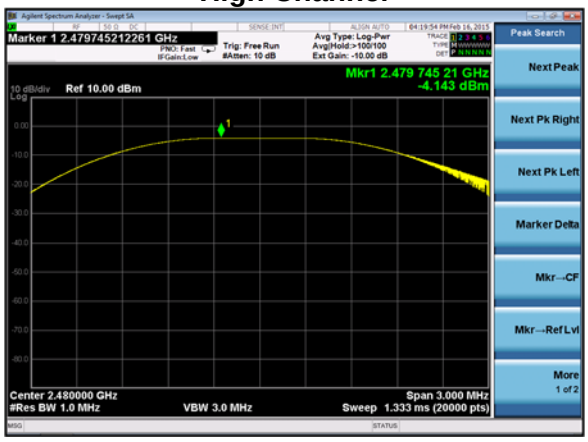


EXHIBIT 10 POWER SPECTRAL DENSITY: 15.247(e)

10.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e) and RSS 210 A8.2(b), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed using the utility built into the analyzer. The resultant density was then corrected to a 3 kHz bandwidth. The highest density was found to be no greater than -11.2 dBm, which is under the allowable limit by 19.2 dB.

10.2 Test Equipment List

Please see Appendix A

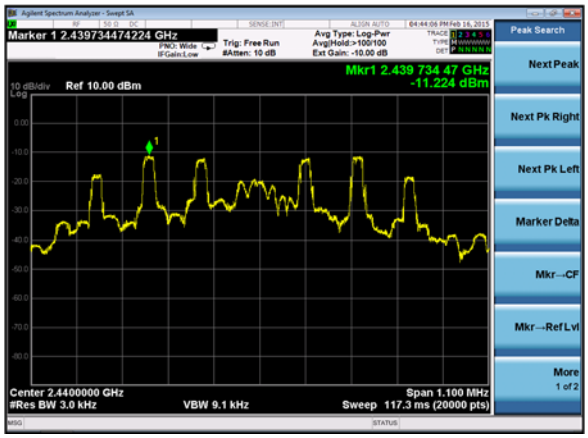
10.3 Test Data

Modulation	Channel	PSD (dBm)	PSD in 3kHz limit(dBm)	PSD margin (dBm)
GFSK	2402	-11.7	8.0	19.7
	2440	-11.2	8.0	19.2
	2480	-11.2	8.0	19.2

10.4 Screen Captures – Power Spectral Density

Low Channel

Middle Channel



High Channel

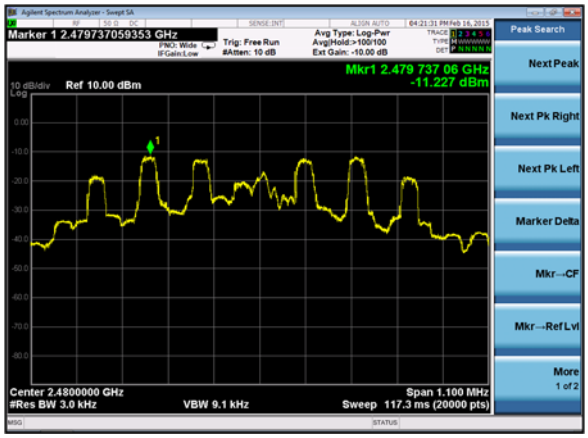


EXHIBIT 11. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

11.1 Limits

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

In addition, radiated emissions, which fall in the restricted band, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(e)

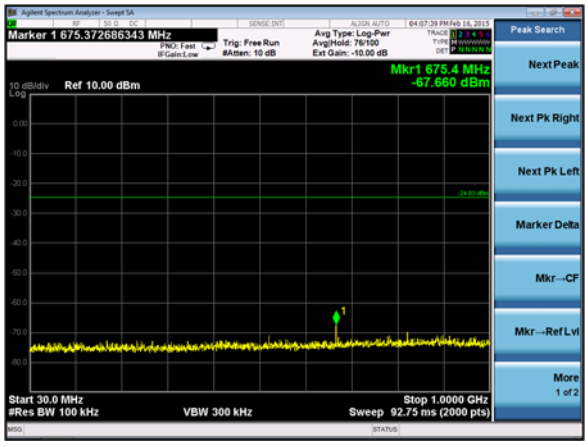
A measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection 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.

11.2 Test Equipment List

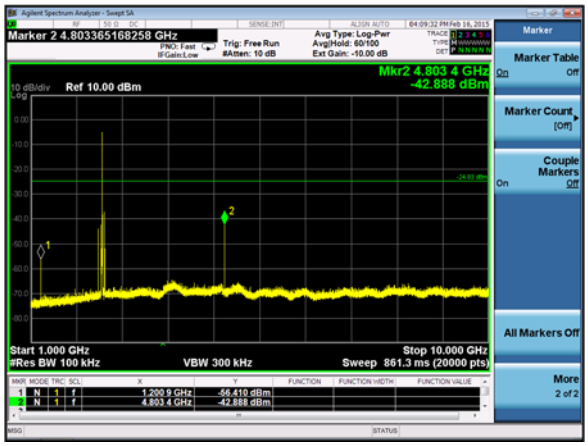
Please see Appendix A

11.3 Screen Captures – Spurious Radiated Emissions

Low Channel shown from 30 MHz up to 1000 MHz



Low Channel shown from 1000 MHz up to 10000 MHz



Low Channel shown from 10000 MHz up to 25000 MHz

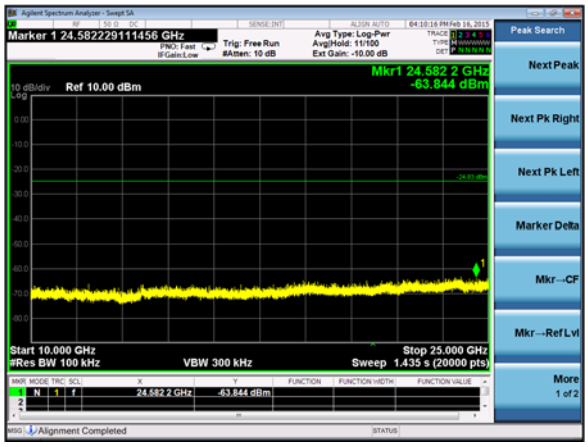


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

The stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer.

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=1 kHz settings while the voltage was varied.

Frequency Stability Over Voltage

2.55 VDC	3.0 VDC	3.45 VDC	
Frequency	Frequency	Frequency	Channel
2402000625	2402000975	2402001300	Low
2440000686	2440001065	2440001425	Middle
2480000735	2480000936	2480001569	High

Frequency Drift (Hz)

Channel	max	min	freq drift (Hz)
Low	2402001300	2402000625	675
Middle	2440001425	2440000686	739
High	2480001569	2480000735	834

Limits

	Low	Mid	High
	2402000000	2440000000	2480000000
100 PPM (Hz) =	240200	244000	248000

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

APPENDIX A

TEST EQUIPMENT

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 5-Feb-2015 Type Test : Rad Spurs Emissions Job # : C-2140

Prepared By: Peter Customer : Danlaw Quote #: 315001

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	6/20/2014	6/20/2015	Active Calibration
2	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	740411007	6/20/2014	6/20/2015	Active Calibration
3	AA 960154	2.4GHz High Pass Filter	KWM	HPF-L-14186	7272-02	8/1/2014	8/1/2015	Active Calibration
4	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	Verification	Verification	System
5	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/14/2013	6/14/2015	Active Calibration
6	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	8/9/2014	8/9/2015	Active Calibration
7	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMCO	WLA622-4 / 3160-09	123001	8/20/2014	8/20/2015	Active Calibration
8	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	10/19/2014	10/19/2015	Active Calibration

Project Engineer: Peter Foisen Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 6-Jan-2015 Type Test : Conducted measurement Job # : C-2140

Prepared By: Aidi Customer : Danlaw Quote #: 315001

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	44GHz EXA Spectrum Analyzer	Agilent	N9010A	MY53400296	12/11/2014	12/11/2015	Active Calibration
2	EE 960082	20V/5A DC Power Supply	Tenma	72-8350	G251003005	Verification	Verification	System
3	EE 960001	Multimeter	HP	971A	JP36004055	3/26/2014	3/26/2015	Active Calibration

Project Engineer: Peter Foisen Quality Assurance:

APPENDIX B – TEST STANDARDS: CURRENT PUBLICATION DATES

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2014		
ANSI C63.10	2013		
CISPR 16-1-1 Note 1	2010		
CISPR 16-1-2 Note 1	2003	2004-04	2006-07
CISPR 22	2008		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2009		
KDB 558074 D01 Meas. Guidance	2000		
RSS GEN	2010		
RSS 102	2015		
RSS 247	2015		

APPENDIX C
Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V