

ELECTROMAGNETIC COMPATIBILITY TEST REPORT

PREPARED FOR FATHOM SYSTEMS INC.
BY QAI LABORATORIES



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American Association for Laboratory Accreditation Certificate Number: 3657.02

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Applicable Test Standards:

FCC Title 47 CFR Part 15: Subpart C
RSS-247 Issue 1
RSS-Gen Issue 4
FCC Title 47 CFR Part 15: Subpart B
ICES-003 Issue 6

Equipment Tested: Fathom Tag

Model Number: TAG0310

FCC ID: 2ALHE-TAG0310

IC Certification Number: 22506-TAG0310

Manufacturer: Fathom Systems Inc.



REVISION HISTORY

Date	Report Number	Rev #	Details	Author's Initials
April 3, 2017	E10749-1603_FathomTag	0.0	Initial Release	HZ
April 11, 2017	E10749-1603_FathomTag	1.0	Final Release	HZ
April 26, 2017	E10749-1603_FathomTag	1.1	Report Update as per TCB's first review	HZ

All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.

REPORT AUTHORIZATION

The data documented in this report is for the test equipment provided by Fathom Systems. Tests were conducted on the sample equipment as requested by Fathom Systems for the purpose of demonstrating compliance with FCC Title 47 CFR Part 15: Subpart B, ICES-003 Issue 6, FCC Title 47 CFR Part 15: Subpart C, RSS-247 Issue 1, and RSS-Gen Issue 4 as agreed upon by Fathom Systems as per Quote 16SH10125R1.

Fathom Systems is responsible for the tested product configuration, continued product compliance, and for the appropriate auditing of subsequent products as required. This report may comprise partial list of tests that are required for FCC or IC Declaration of Conformity and can only be produced by the manufacturer.

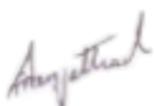
This is to certify that the following report is true and correct to the best of our knowledge.



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QAI FACILITIES

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QAI EMC ACCREDITATION

QAI EMC is your one-stop regulatory compliance partner for electromagnetic compatibility (EMC) and electromagnetic interference (EMI). Products are tested to the latest and applicable EMC/EMI requirements for domestic and international markets. QAI EMC goes above and beyond being a testing facility—we are your regulatory compliance partner. QAI EMC has the capability to perform RF Emissions and Immunity for all types of electronics manufacturing including Industrial, Scientific, Medical, Information Technology, Telecom, Wireless, Automotive, Marine and Avionics.

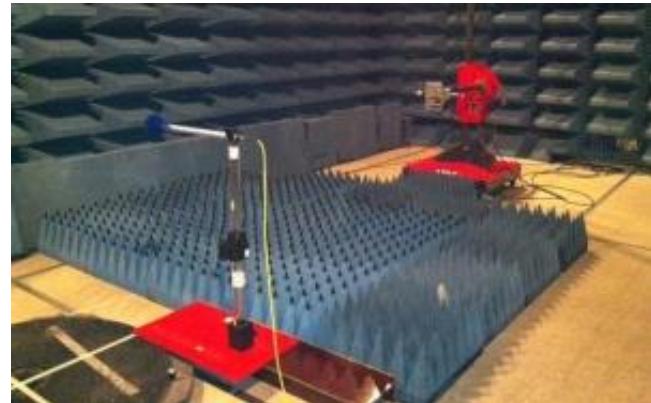
EMC Laboratory Location	FCC Designation (3m SAC)	IC Registration (3m SAC)	A2LA Certificate
Burnaby, BC Canada	CA9543	21146-1	3657.02



Headquarters & EMC Laboratory in Burnaby, BC



Chamber 1- 3m Semi-Anechoic Chamber (SAC) in Burnaby, BC



Chamber 1- 3m Semi-Anechoic Chamber (SAC) in Burnaby, BC



Chamber 2- 3m Semi-Anechoic Chamber (SAC) in Burnaby, BC



Chamber 2- 3m Semi-Anechoic Chamber (SAC) in Burnaby, BC



10m Open Area Test Site (OATS) in British Columbia, Canada

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Section I: EXECUTIVE SUMMARY

1.1 Purpose

The purpose of this report is to demonstrate and document the compliance of “Fathom Tag” as per Sections 1.2 & 1.3.

1.2 Scope

The information documented in this report is based on the test methods and levels as per Quote 16SH10125R1:

- **FCC Title 47 CFR Part 15** – Radio Frequency Devices, Subpart C – Intentional Radiators
 - o 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz
- **RSS-247 Issue 1** – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
- **RSS-Gen Issue 4** – General Requirements and Information for the Certification of Radio Apparatus
- **FCC Title 47 CFR Part 15** – Radio Frequency Devices, Subpart B – Unintentional Radiators
- **ICES-003 Issue 6** – Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement

The tests documented in this report were performed in accordance with ANSI C63.4-2014, ANSI C63.10-2013, RSS-Gen Issue 4 and FCC KDB 558074 D01 DTS Meas Guidance v03r05.

1.3 Summary of Results

The following tests demonstrate the testimony to “FCC and IC” Mark Electromagnetic compatibility testing for “Fathom Tag” manufactured by Fathom Systems.

The following testing was performed pursuant to the FCC and IC Radio and RF Emissions Standards:

Test or Measurement	Applicable FCC and IC Standard	Clause	Result
Antenna Requirement	FCC Title 47 CFR Part 15: Subpart C	§15.203	Complies
	RSS-Gen Issue 4	8.3	
RF Peak Power Output	FCC Title 47 CFR Part 15: Subpart C	§15.247 (b)(3)	Complies
	RSS-247 Issue 1	5.4 (4)	
6dB Occupied Bandwidth	FCC Title 47 CFR Part 15: Subpart C	§15.247 (a)(2)	Complies
	RSS-247 Issue 1	5.2 (1)	
99% Occupied Bandwidth	RSS-Gen Issue 4	6.6	Complies
Power Spectral Density	FCC Title 47 CFR Part 15: Subpart C	§15.247 (e)	Complies
	RSS-247 Issue 1	5.2 (2)	
Out-of-Band Emissions (Band Edge)	FCC Title 47 CFR Part 15: Subpart C	§15.247 (d)	Complies
	RSS-247 Issue 1	5.5	
Conducted Spurious Emissions	FCC Title 47 CFR Part 15: Subpart C	§15.247 (d)	Complies
	RSS-247 Issue 1	5.5	
Radiated Spurious Emissions – Transmit Mode	FCC Title 47 CFR Part 15: Subpart C	§15.209 §15.205	Complies
	RSS-Gen Issue 4	8.9 8.10	
Radiated Emissions – Receive Mode	FCC Title 47 CFR Part 15: Subpart B	§15.109	Complies
	ICES-003 Issue 6 RSS-Gen Issue 4	6.2 7.1	
Frequency Stability	FCC Title 47 CFR Part 15: Subpart C	§15.215 (c)	Complies
	RSS-Gen Issue 4	8.8	
RF Exposure Evaluation	FCC Title 47 CFR Part 1: Subpart I	§1.1310	Complies
	RSS-102	2.5.2	

Section II: GENERAL INFORMATION

2.1 Product Description

The information provided in this section is for the Equipment Under Test (EUT) and the corresponding Ancillary Equipment needed to perform the tests as complete system.



EUT – Fathom Tag

Equipment Under Test (EUT) Information

EUT	Fathom Tag
Description	a battery-powered Bluetooth Low Energy (BLE) beacon
FRN	0026348300
FCC ID	2ALHE-TAG0310
IC Number	22506-TAG0310
Manufacturer	Fathom Systems Inc.
Model No.	TAG0310

Frequency Band	2400-2483.5 MHz
Transmit Power	4dBm
Test Channels	40
Data Rate	1 Mb/s 2 Mb/s ~ proprietary protocol
Antenna Type and Gain	2450MHz Chip Antenna; peak gain 0.5dBi

EUT Input Power Specification

Battery Powered	CR123A 3Volts Li-MnO ₂ cell, 1500-2000mAHR, 25mA max current
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2.2 Environmental Conditions

The equipment under test was operated and tested under the following environmental conditions:

Parameter	Conditions
Location	Indoors
Temperature	22-28°C
Relative Humidity	39.7 - 54.4%

2.3 Measurement Uncertainty

Parameter	Uncertainty
Radiated Emissions, 30MHz-1GHz	± 2.40 dB
Radiated Emissions, 1GHz-40GHz	± 2.48 dB
Radio Frequency	±1,5 x 10-5 MHz
Total RF Power Conducted	±1.36 dB
Spurious Emissions, Conducted	±1.36 dB
RF Power Density, Conducted	±1.36 dB
Temperature	±1°C
Humidity	±5 %
DC and low frequency voltages	±3 %

2.4 Worst Test Case

Worst-case orientation was determined during the preliminary testing. The final radiated emissions were performed in the worst-case orientation.

2.5 Sample Calculations of Emissions Data

Radiated and conducted emissions were performed using EMC32 software developed by Rohdes & Schwarz. Transducer factors like Antenna factors, Cable Losses and Amplifier gains were stored in the test templates which are used to perform the emissions measurements. After test is finished, data is generated from the EMC32 consisting of product details, emission plots and final data tables as shown below.

Frequency (MHz)	Quasi-Peak (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turtable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB μ V/m)
42.663900	33.0	1000.000	120.000	100.0	H	70.0	13.2	7.5	40.5

Quasi Peak reading shown in the table above is already corrected by the software using correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

$$\text{Corr.(dB)} = \text{Antenna factor} + \text{Cable loss}$$

Or

$$\text{Corr.(dB)} = \text{Antenna factor} + \text{Cable Loss} - \text{Amp gain (if pre-amplifier was used)}$$

The final Quasi peak reading shown in the data is calculated by the software using following equation:

$$\text{Corrected Quasi Peak(dB μ V/m)} = \text{Raw Quasi Peak Reading} + \text{Antenna factor} + \text{Cable loss}$$

To obtain the final Quasi-Peak or Average reading during power line conducted emissions, transducer factors are included in the final measurement as shown below.

Frequency (MHz)	QuasiPeak (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150	44.3	1000.000	9.000	0.6	21.7	66.0

Frequency (MHz)	Average (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150	27.2	1000.000	9.000	0.6	28.8	56.0

Note: Data shown above are sample data and are not relevant to the EUT's actual data.

Quasi Peak or Average reading shown in above table is already corrected by the software using the correction factor shown in column “Corr.” The correction factor listed under “Corr.” table calculated as:

$$\text{Corr.(dB)} = \text{Antenna factor} + \text{Cable loss}$$

The final Quasi peak or Average reading shown in the data is calculated by the software using following equation:

$$\text{Corr. Quasi Peak/Average Reading (dB μ V)} = \text{Raw Quasi Peak/Average Reading} + \text{Antenna factor} + \text{Cable loss}$$

The allowable margin from the limits, as per the standards, were calculated for both radiated and conducted emissions:

$$\text{Margin(dB)} = \text{Limit} - \text{Quasi-Peak or Average reading}$$

2.6 Test Equipment List

The tables below contain all the equipment used by QAI Laboratories in conducting all tests on the Equipment Under Test (EUT) as per Section 1.3.

Emissions Test Equipment

Manufacturer	Model	Description	Serial No.	Calibration Due Date
Sunol Sciences	SM46C	Turntable	051204-2	N/A
Sunol Sciences	TWR95	Mast	TREML0001	N/A
Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A120106	24-Sep-2017
Sunol Sciences	DRH-118	Horn Antenna 1GHz-18GHz	A050905	10-Mar-2019
ETS Lindgren	3160-09	Horn Antenna 18GHz-26.5GHz	9701-1071	30-Aug-2017
ETS Lindgren	3160-10	Horn Antenna 26.5GHz-40.0GHz	9708-1075	30-Aug-2017
ETS Lindgren	6502	Active Loop Antenna 10kHz – 30MHz	2178	21-Aug-2017
ETS Lindgren	2165	Turntable	00043677	N/A
ETS Lindgren	2125	Mast	00077487	N/A
Rohde & Schwarz	ESU40	EMI Receiver	100011	20-Nov-2017
Fischer	FCC-LISN-50-25-2-08	LISN (150kHz-30MHz)	2041	19-Nov-2018
ETS Lindgren	S201	5-meter Semi-Anechoic Chamber	1030	N/A
AH Systems	PAM118	Amplifier 10KHz-18GHz	189	09-March-2017
California Instruments	PACS-1	Harmonics and flicker analyzer	72569	18-July-2018
California Instruments	OMNI 1-18 I	Programmable Impedance Flicker test	-	18-July-2018
California Instruments	3001ix	Power supply	HK52117	18-July-2018

Note: Equipment listed above have a 3 years calibration interval.

Measurement Software List

Manufacturer	Model	Version	Description
Rhode & Schwarz	EMC 32	6.20.0	Emissions Test Software
ETS-Lindgren	Tile7	7.3.15	Emissions Test Software

Section III: REQUIREMENTS FOR THE US MARKET (FCC) & THE CANADIAN MARKET (IC) - Exigences pour le Marché Canadien

3.1 Antenna Requirements

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.203
- RSS-Gen Issue 4: Clause 8.3

Applicable Regulation:

The purpose of this requirement is to make certain that no other antenna, except for that provided by the responsible party, shall be used with the Equipment-Under-Test (EUT) as defined in FCC CFR 47 Part 15.203 & RSS-Gen Issue 4:

“An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited.” ... “the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.”

Modifications:

No modification was required to comply for this test.

Result:

A chip antenna is integrated and permanently attached in the printed circuit board.
EUT meets the antenna requirement.

3.2 RF Peak Output Power

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (b)(3)
- RSS-247 Issue 1: Clause 5.4 (4)

Test Method:

- FCC KDB 558074 D01 DTS Meas Guidance v03r05

Test Requirement:

For systems employing digital modulation techniques operating in the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz, the maximum peak conducted output power shall not exceed 1 W (30dBm). Except as provided in RSS 210 Section A8.4 (5), the e.i.r.p. shall not exceed 4 W.

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

Measurement Method:

The following are measurement methods used on each radio as per FCC KDB 558074 D01 DTS Meas Guidance v03r05:

- Section 9.1.1: $\text{RBW} \geq \text{DTS bandwidth}$

Modifications:

No modification was required to comply for this test.

Result:

The maximum conducted RF peak power measurement is 2.47dBm or 0.00177W.

The EUT complies with the applicable standard.

Remark:

A special antenna was provided in the internal circuitry of the EUT by the client and was only used for conducted peak power output measurements.

Measurement Data and Plot:

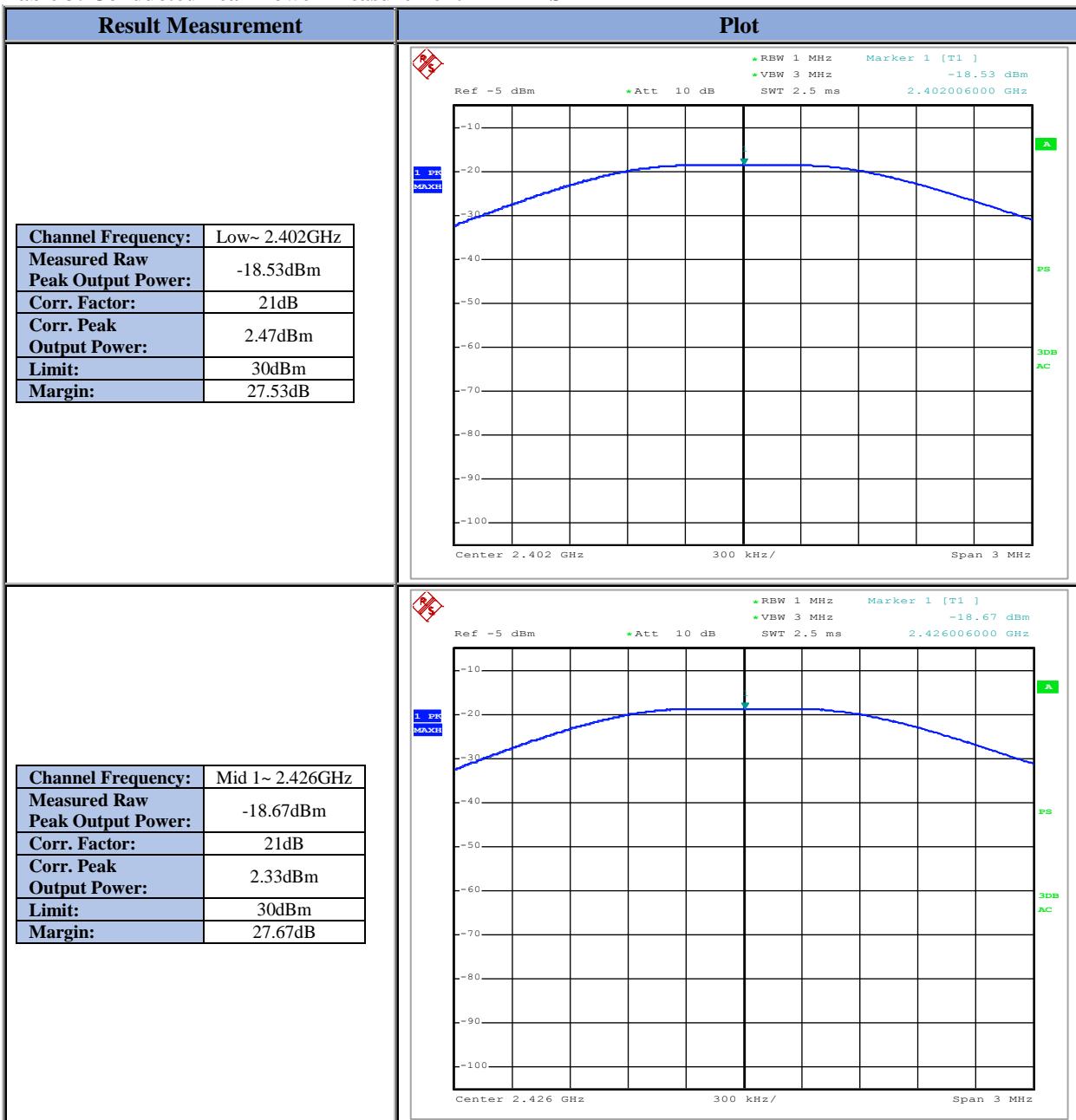
Table 1: E.I.R.P measurements – 1MBPS

Channel	Frequency	Measured Raw Peak Output Power	Corr. Factor	Corr. Peak Output Power	Antenna Gain	EIRP	Limit	Margin
	(MHz)	(dBm)	(dB)	(dBm)	(dB)	(dBm)	(dBm)	(dB)
Low	2402	-18.53	21	2.47	0.5	2.97	36	33.03
Mid 1	2426	-18.67	21	2.33	0.5	2.83	36	33.17
Mid 2	2440	-18.72	21	2.28	0.5	2.78	36	33.22
High	2480	-18.58	21	2.42	0.5	2.92	36	33.08

Table 2: E.I.R.P measurements – 2MBPS

Channel	Frequency	Measured Raw Peak Output Power	Corr. Factor	Corr. Peak Output Power	Antenna Gain	EIRP	Limit	Margin
	(MHz)	(dBm)	(dB)	(dBm)	(dB)	(dBm)	(dBm)	(dB)
Low	2402	-18.53	21	2.47	0.5	2.97	36	33.03
Mid 1	2426	-18.68	21	2.32	0.5	2.82	36	33.18
Mid 2	2440	-18.71	21	2.29	0.5	2.79	36	33.21
High	2480	-18.62	21	2.38	0.5	2.88	36	33.12

Table 3: Conducted Peak Power Measurement – 1MBPS



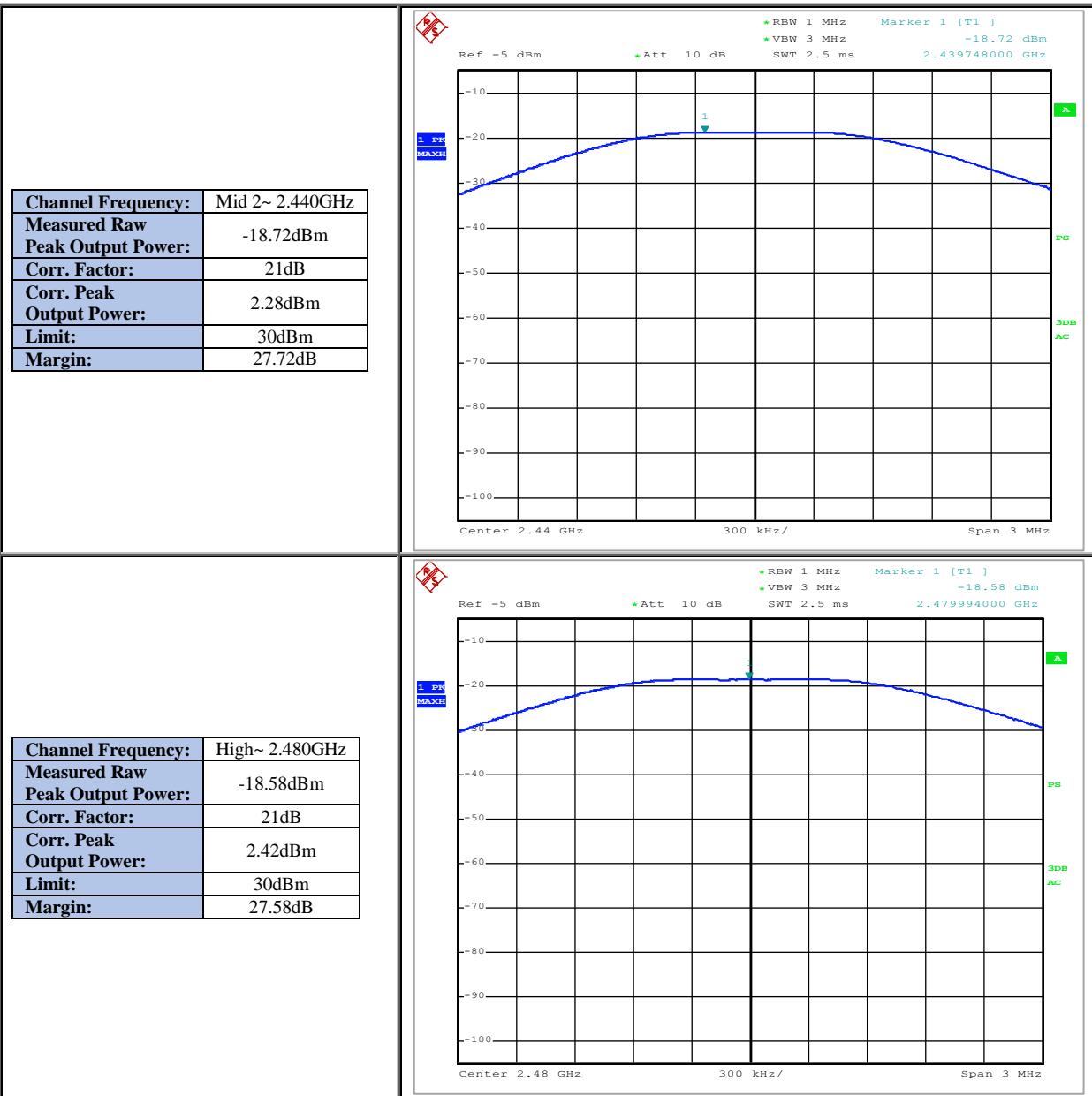
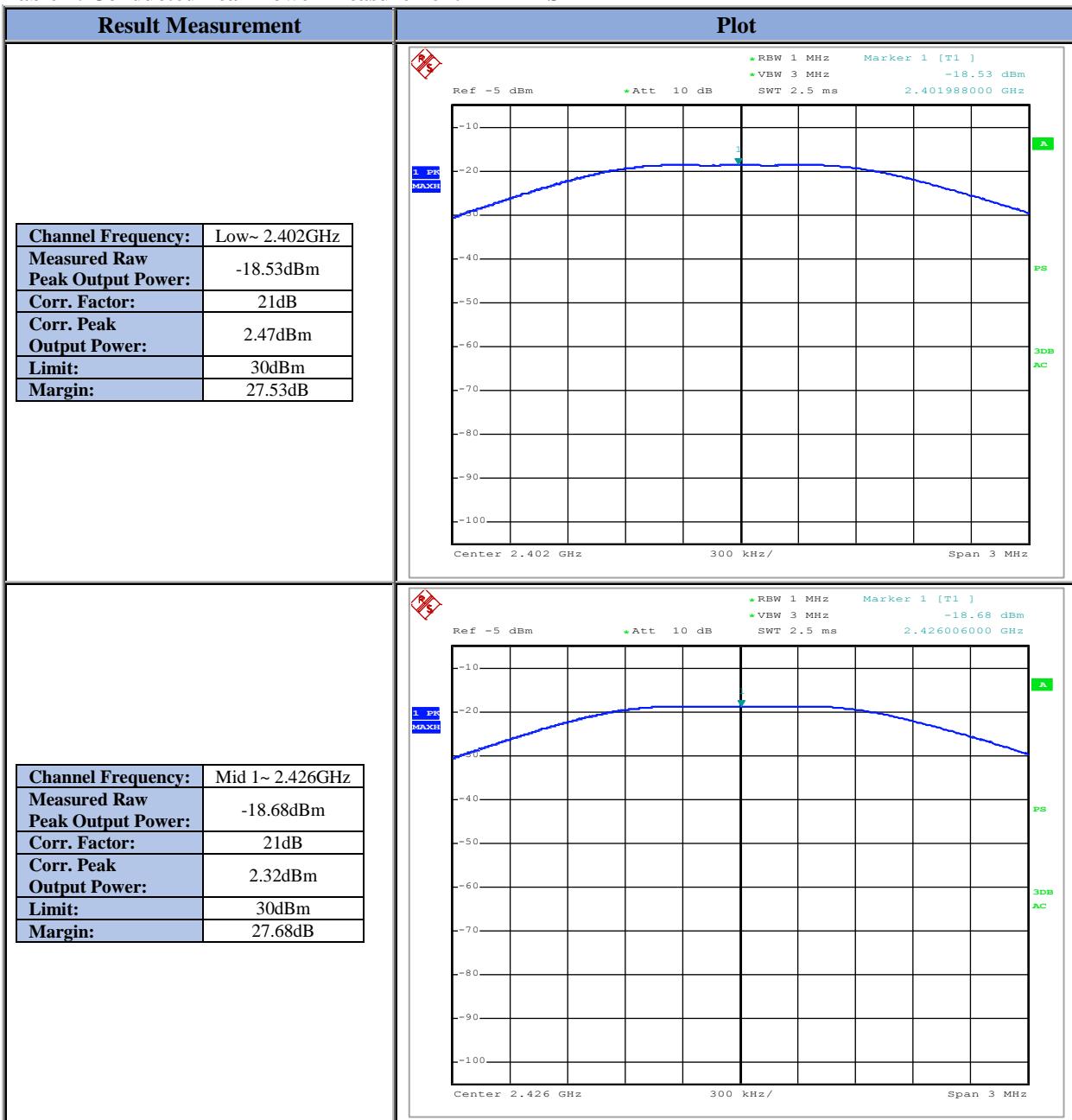
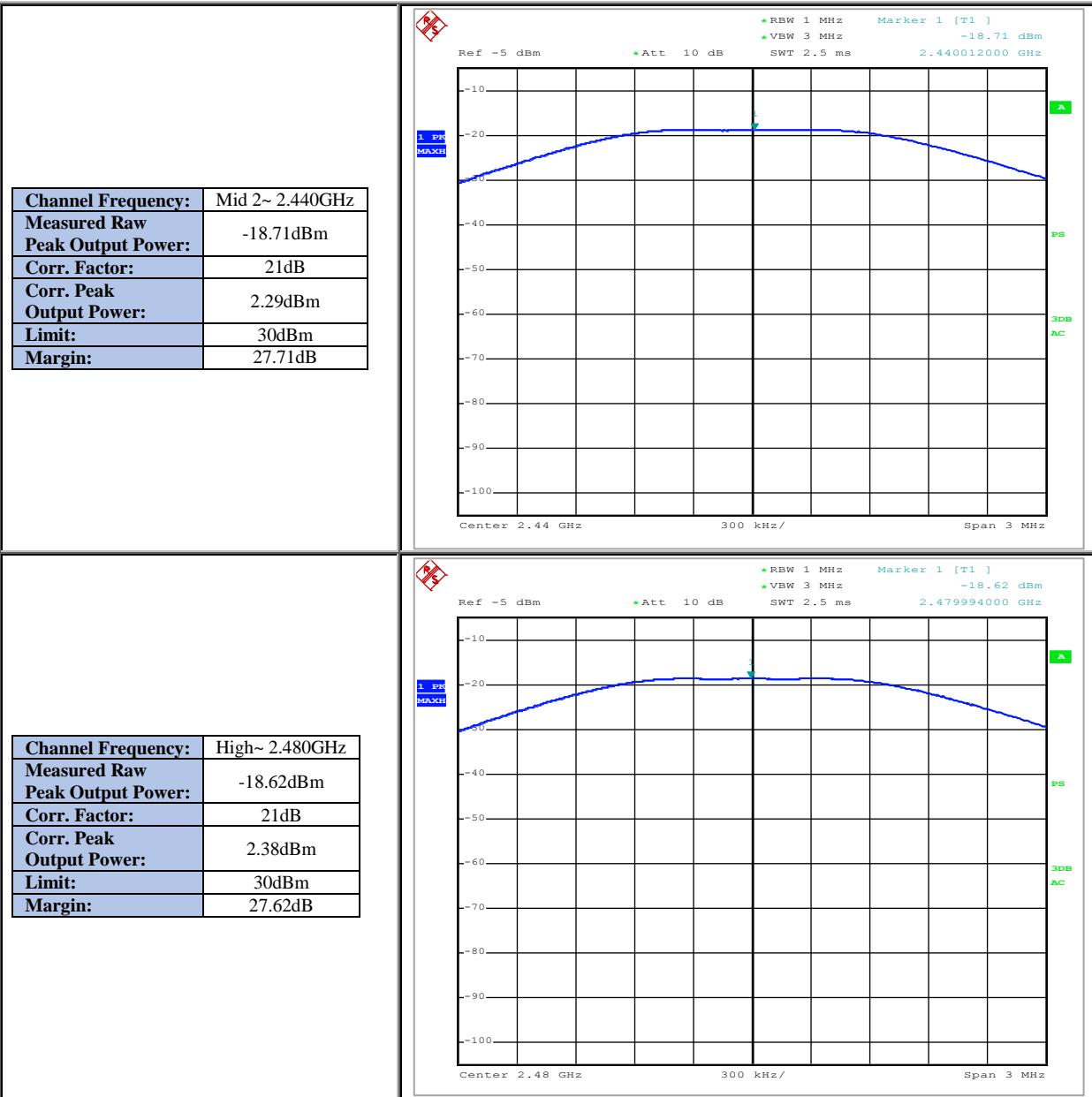


Table 4: Conducted Peak Power Measurement – 2MBPS





3.3 6dB Occupied Bandwidth

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (a)(2)
- RSS-247 Issue 1: Clause 5.2 (1)

Test Method:

- ANSI C63.10:2013

Test Requirement:

The minimum 6dB bandwidth shall be at least 500kHz.

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

Measurement Method:

As called in ANSI C63.10-2013 and RSS-Gen Issue 4

Modifications:

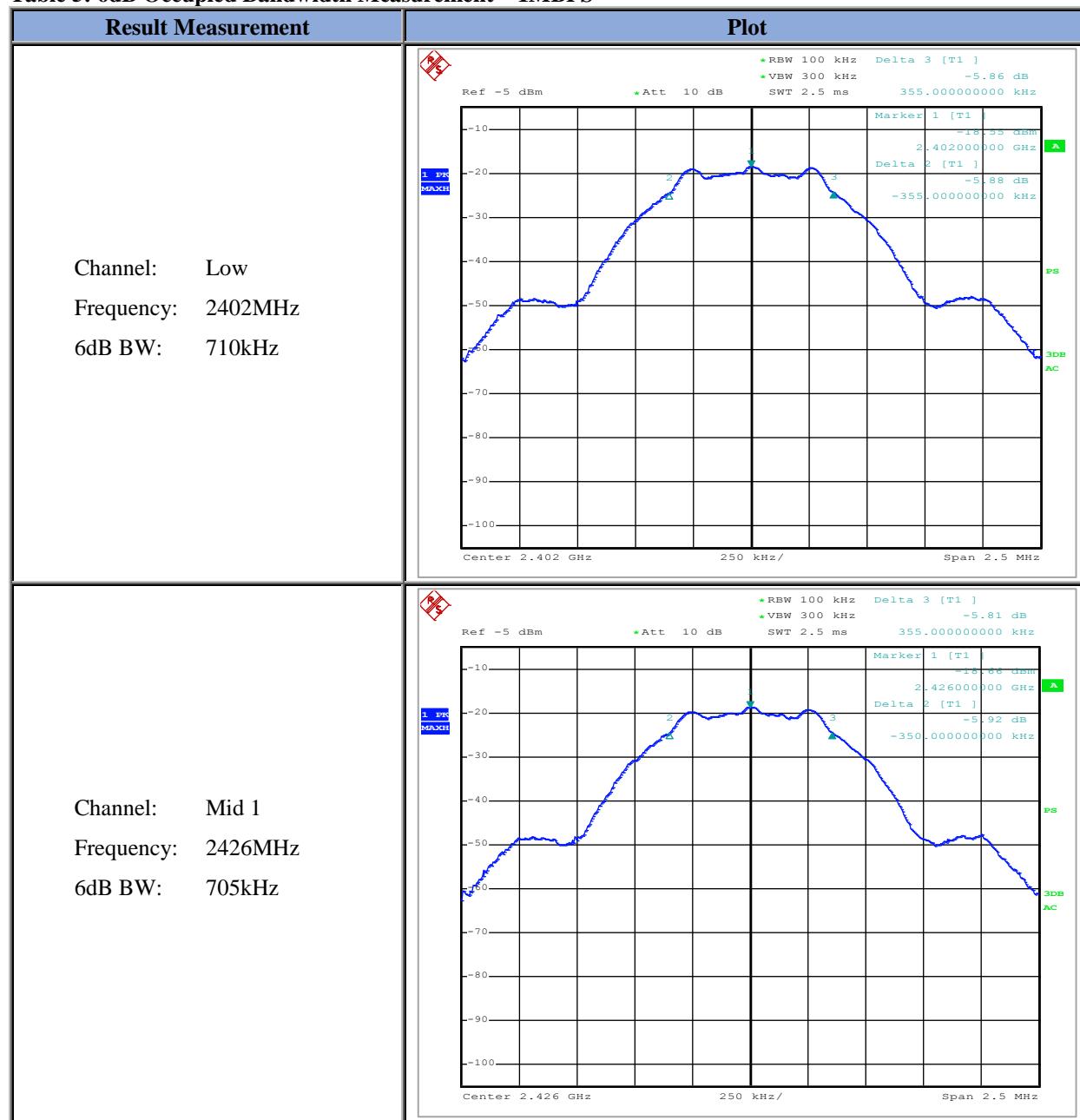
No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Table 5: 6dB Occupied Bandwidth Measurement – 1MBPS



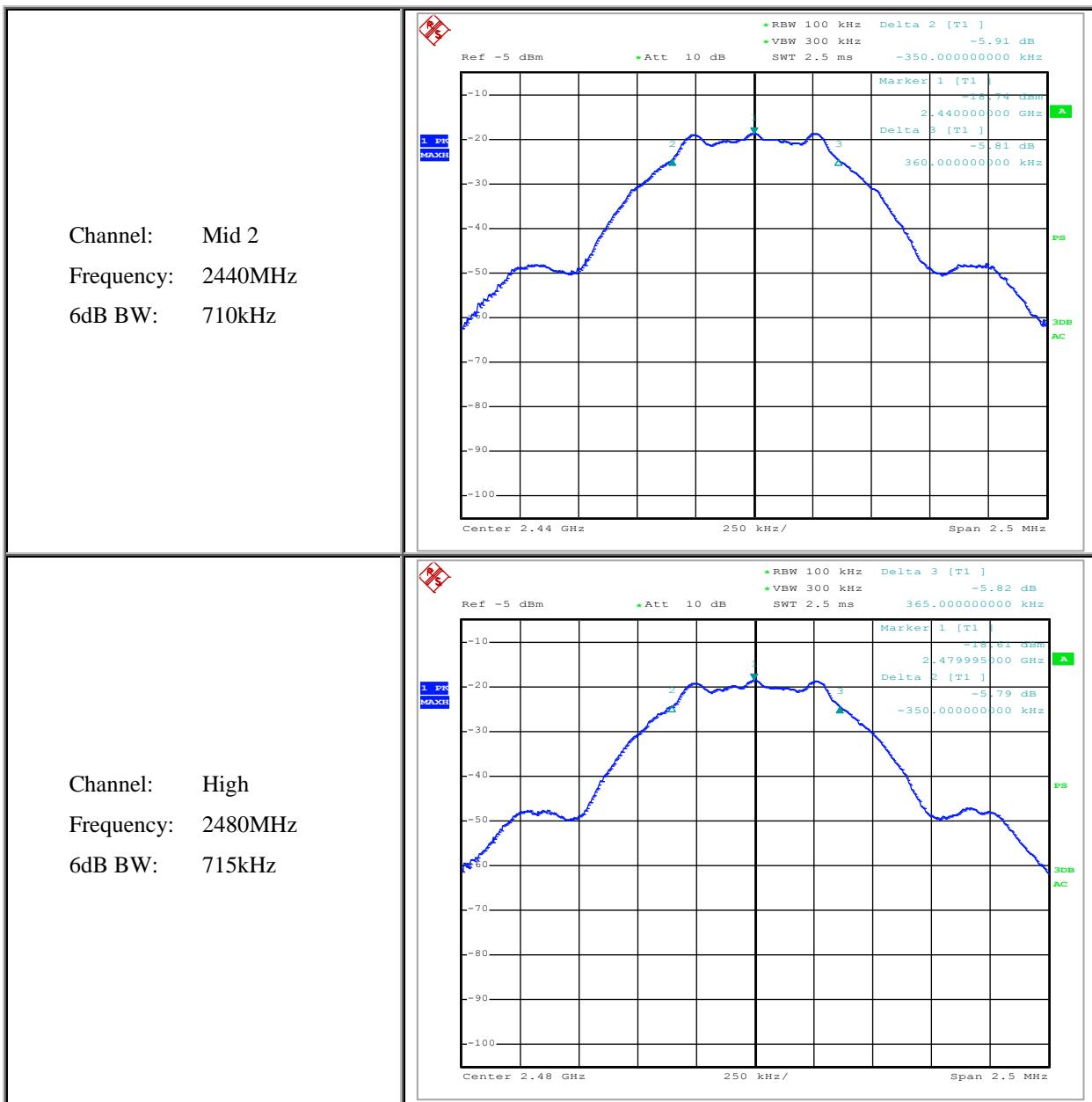
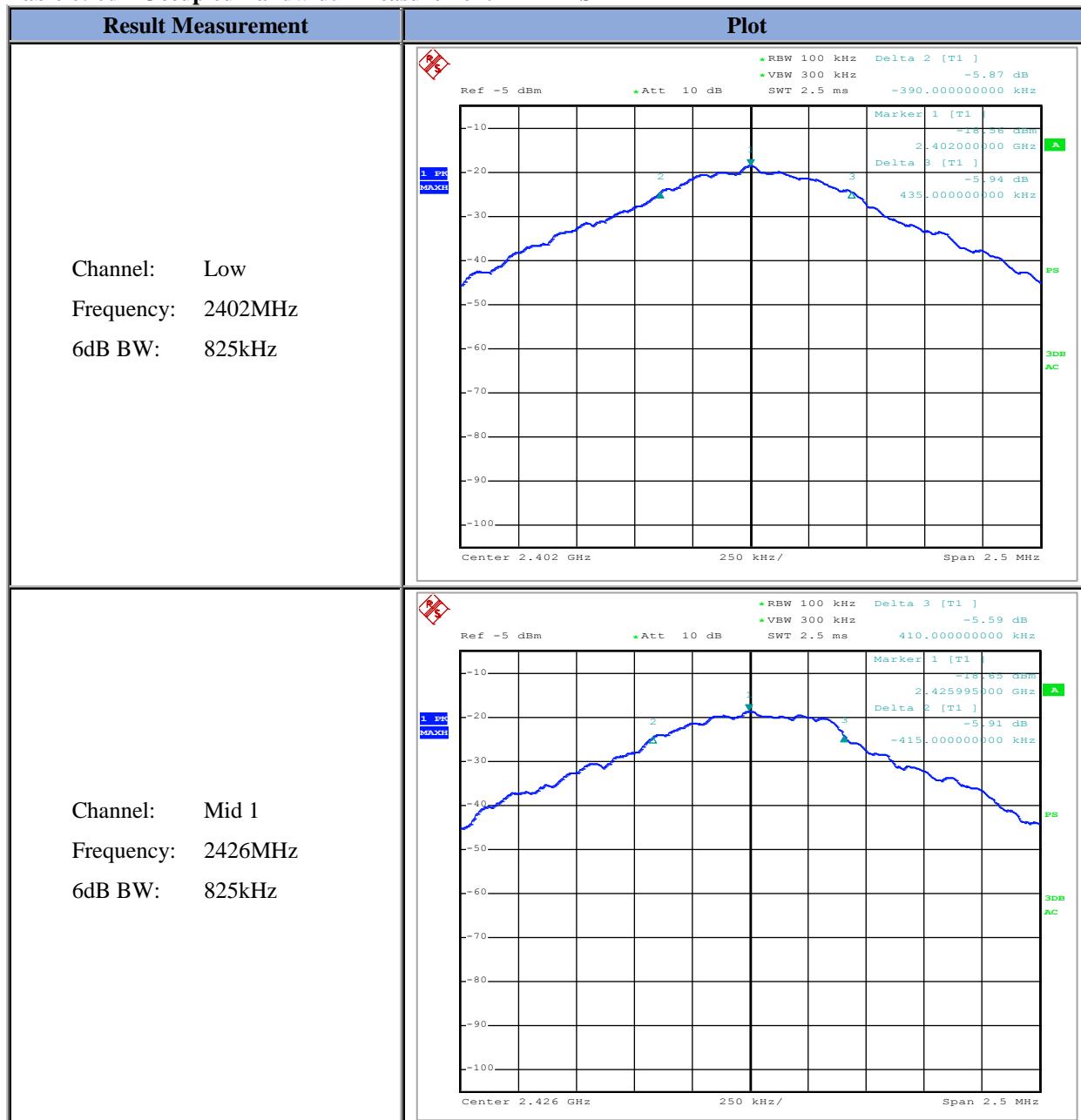
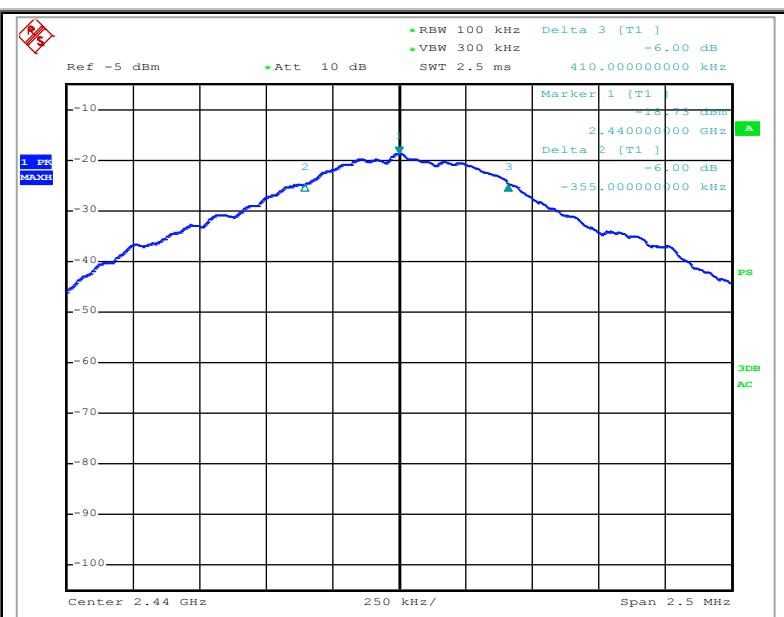


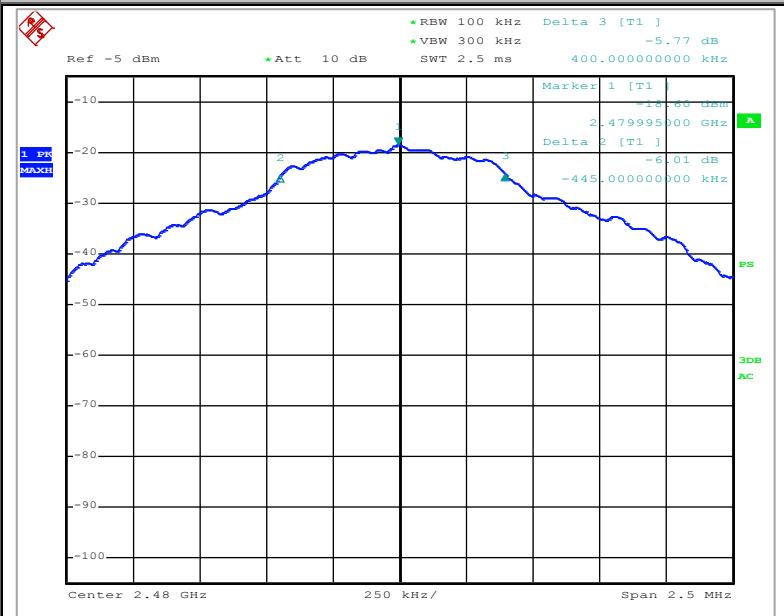
Table 6: 6dB Occupied Bandwidth Measurement – 2MBPS



Channel: Mid 2
Frequency: 2440MHz
6dB BW: 765kHz



Channel: High
Frequency: 2480MHz
6dB BW: 845kHz



3.4 99% Occupied Bandwidth

Date Performed:

March 9, 2017

Test Standard:

- RSS-Gen Issue 4: Clause 6.6

Test Method:

- ANSI C63.10:2013

Test Setup:

RSS-Gen Issue 4: Section 6.6 – A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

Measurement Method:

As called in ANSI C63.10-2013 and RSS-Gen Issue 4

Modifications:

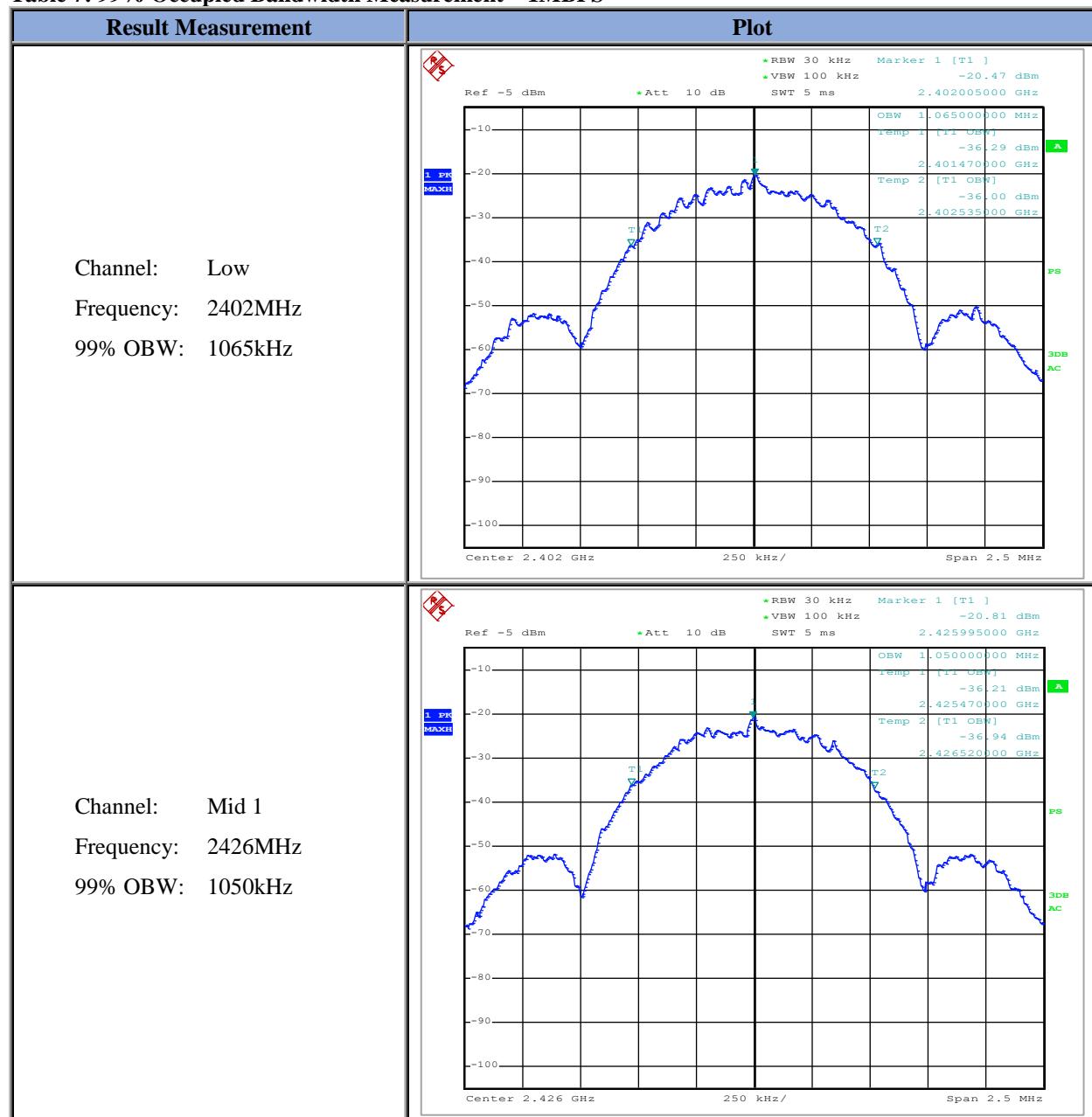
No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Table 7: 99% Occupied Bandwidth Measurement – 1MBPS



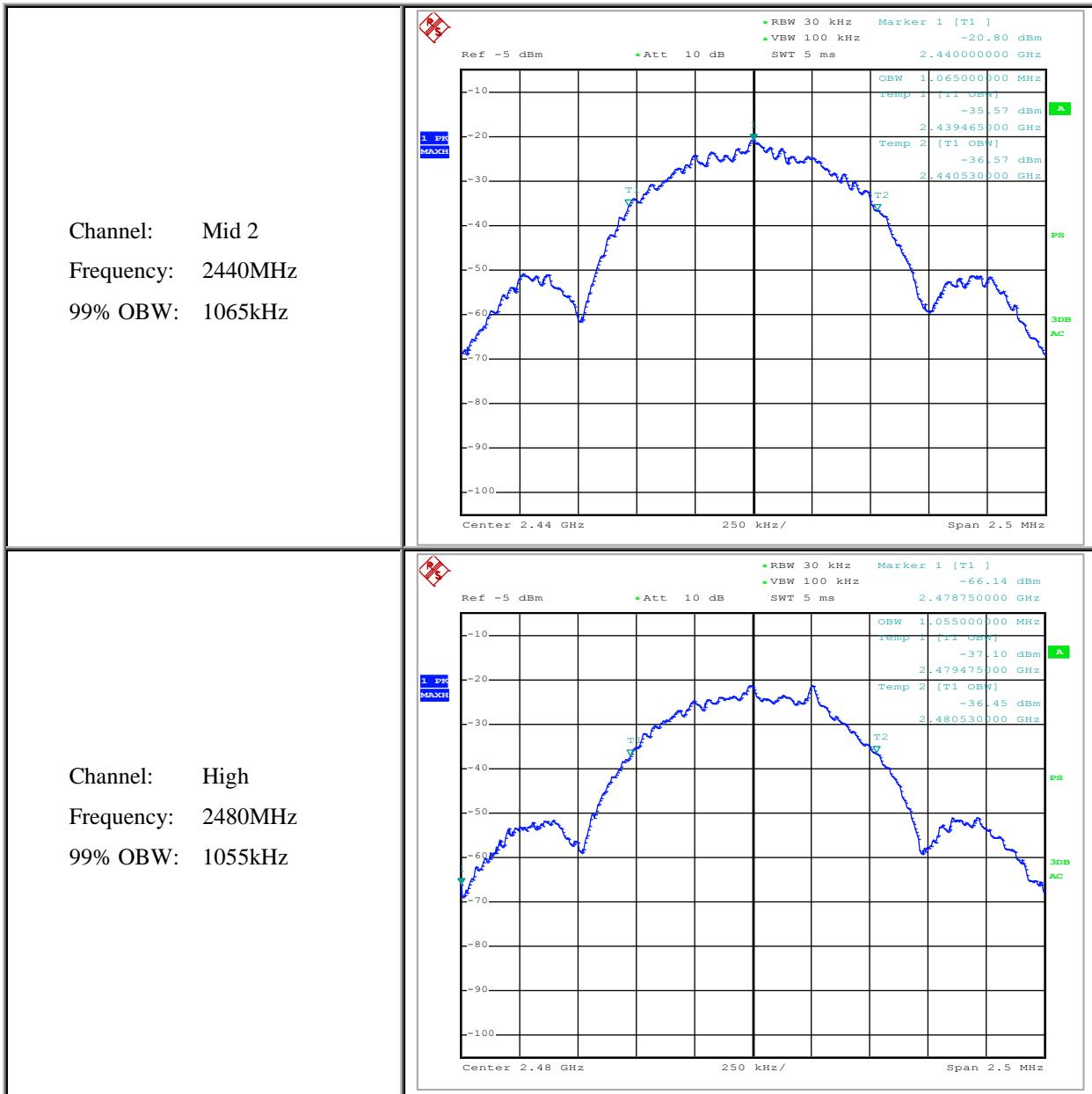
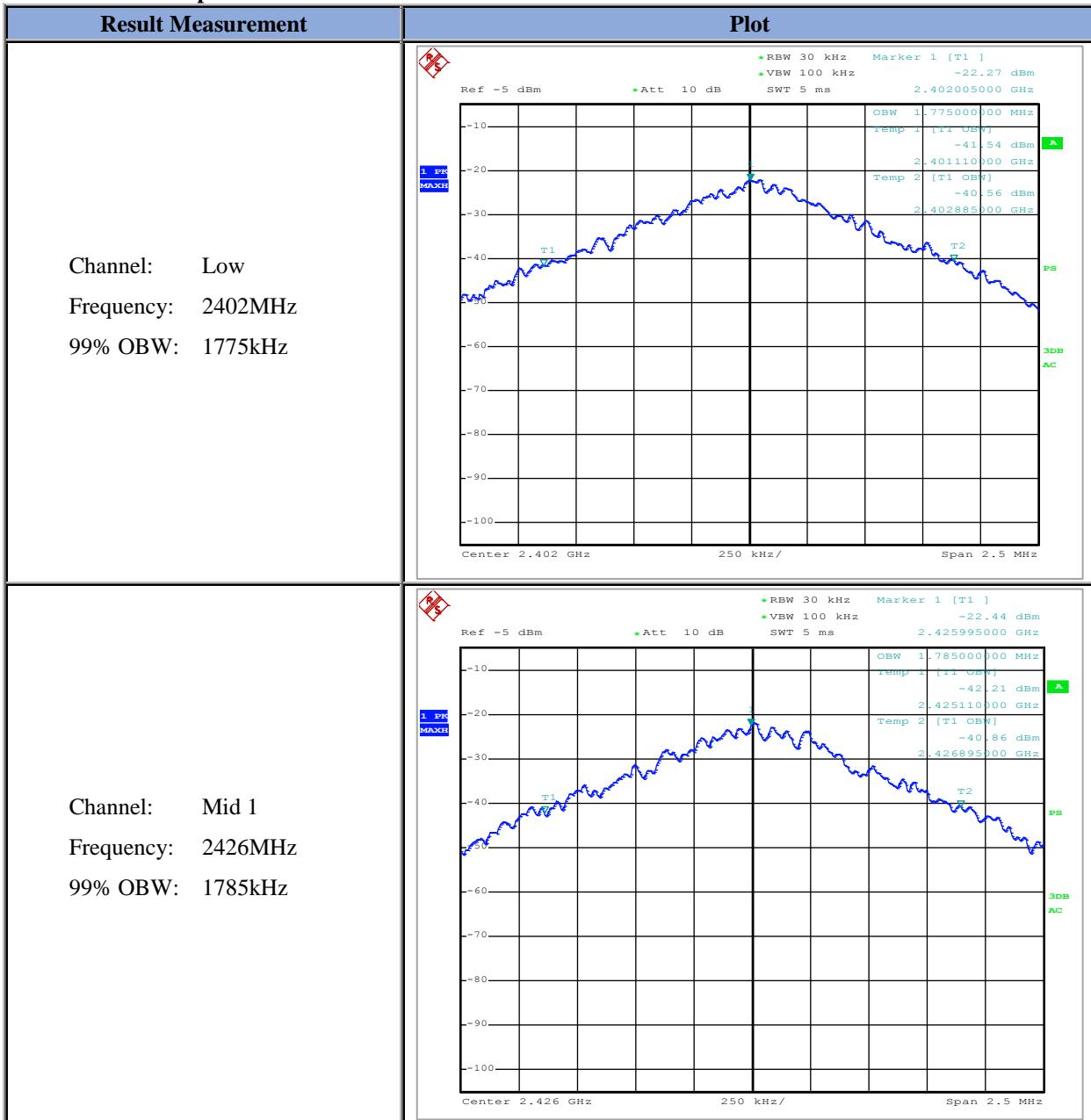
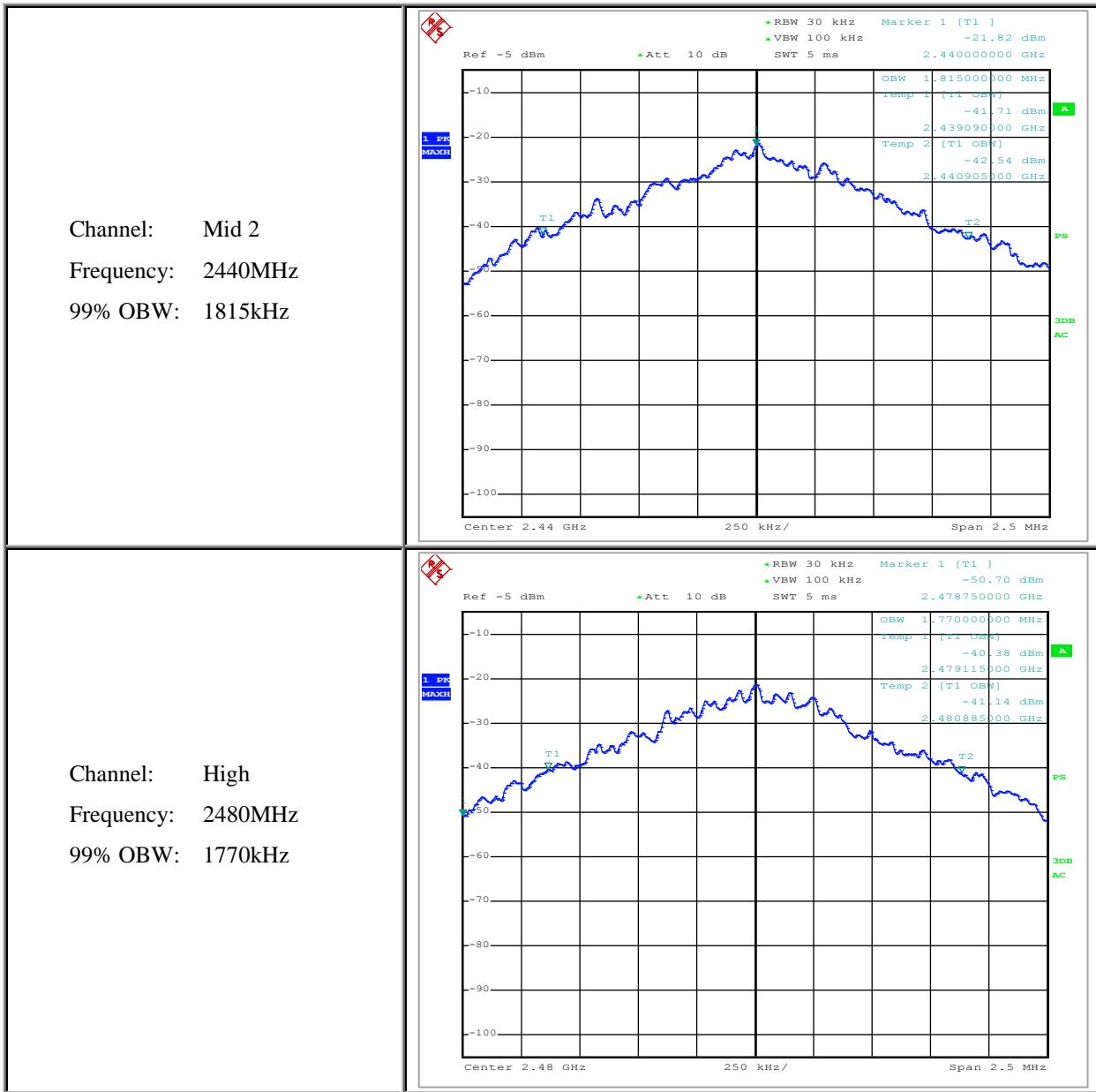


Table 8: 99% Occupied Bandwidth Measurement – 2MBPS





3.5 Power Spectral Density

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (e)
- RSS-247 Issue 1: 5.2 (2)

Test Method:

- FCC KDB 558074 D01 DTS Meas Guidance v03r05

Test Requirement:

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission. The power spectral density was determined using the same method as is used to determine the conducted output power).

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

Measurement Method:

The following are measurement methods used on each radio as per FCC KDB 558074 D01 DTS Meas Guidance v03r05:

- Section 10.2: Method PKPSD (peak PSD)

Modifications:

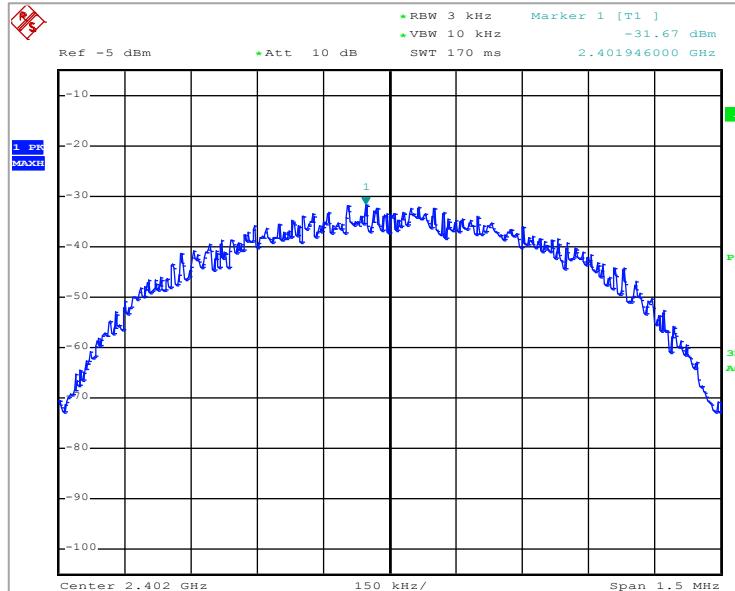
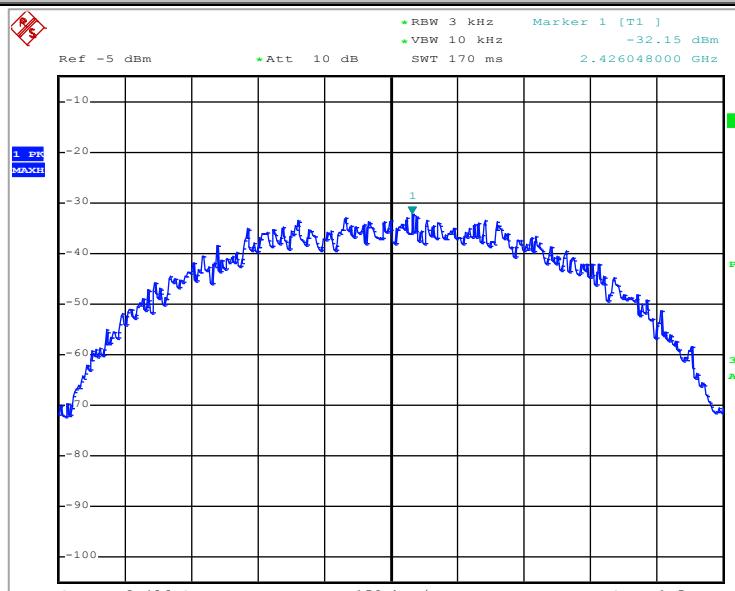
No modification was required to comply for this test.

Result:

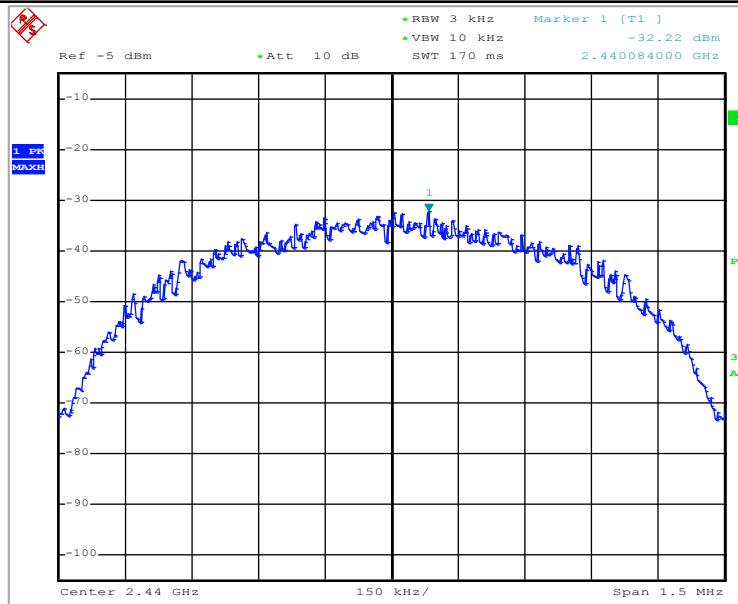
The EUT complies with the applicable standard.

Measurement Data and Plot:

Table 9: Power Spectral Density Measurement – 1MBPS

Result Measurement	Plot
<p>Channel: Low</p> <p>Frequency: 2402MHz</p> <p>Measured PSD: -31.67dBm</p> <p>Corr. Factor: 21dB</p> <p>Corr. PSD: -10.67dBm</p> <p>Limit: 8dBm</p> <p>Margin: 18.67dB</p>	 <p>Ref -5 dBm Att 10 dB SWT 170 ms 2.401946000 GHz</p> <p>RBW 3 kHz Marker 1 [T1] -31.67 dBm</p> <p>VBW 10 kHz</p> <p>PS</p> <p>3dB AC</p> <p>Center 2.402 GHz 150 kHz/ Span 1.5 MHz</p>
<p>Channel: Mid 1</p> <p>Frequency: 2426MHz</p> <p>Measured PSD: -32.15dBm</p> <p>Corr. Factor: 21dB</p> <p>Corr. PSD: -11.15dBm</p> <p>Limit: 8dBm</p> <p>Margin: 19.15dB</p>	 <p>Ref -5 dBm Att 10 dB SWT 170 ms 2.426048000 GHz</p> <p>RBW 3 kHz Marker 1 [T1] -32.15 dBm</p> <p>VBW 10 kHz</p> <p>PS</p> <p>3dB AC</p> <p>Center 2.426 GHz 150 kHz/ Span 1.5 MHz</p>

Channel: Mid 2
 Frequency: 2440MHz
 Measured PSD: -32.22dBm
 Corr. Factor: 21dB
 Corr. PSD: -11.22dBm
 Limit: 8dBm
 Margin: 19.22dB



Channel: High
 Frequency: 2480MHz
 Measured PSD: -29.98dBm
 Corr. Factor: 21dB
 Corr. PSD: -8.98dBm
 Limit: 8dBm
 Margin: -16.98dB

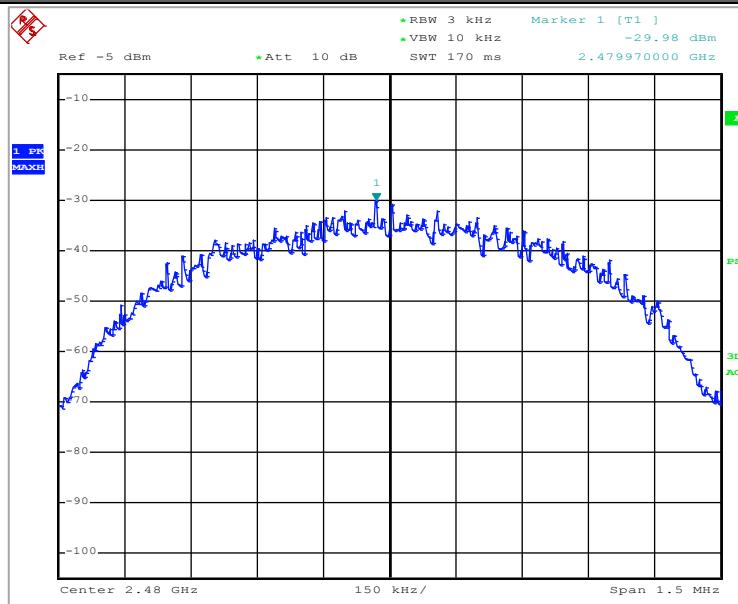
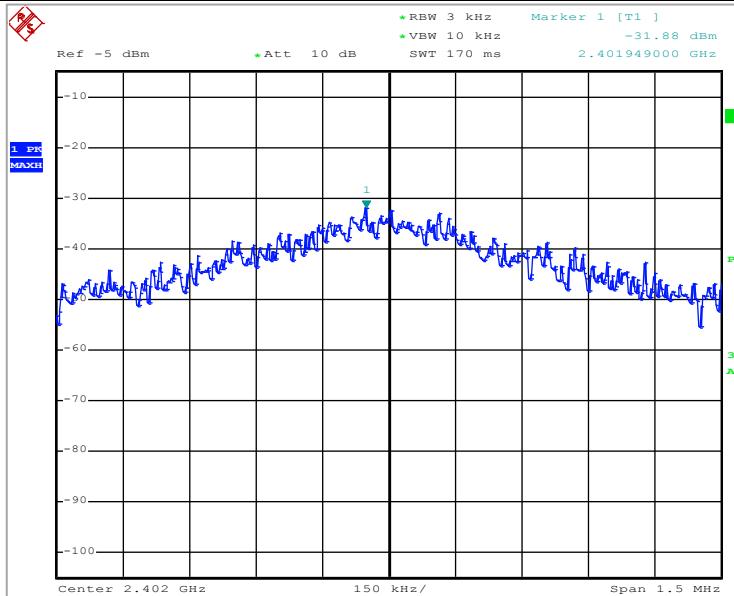
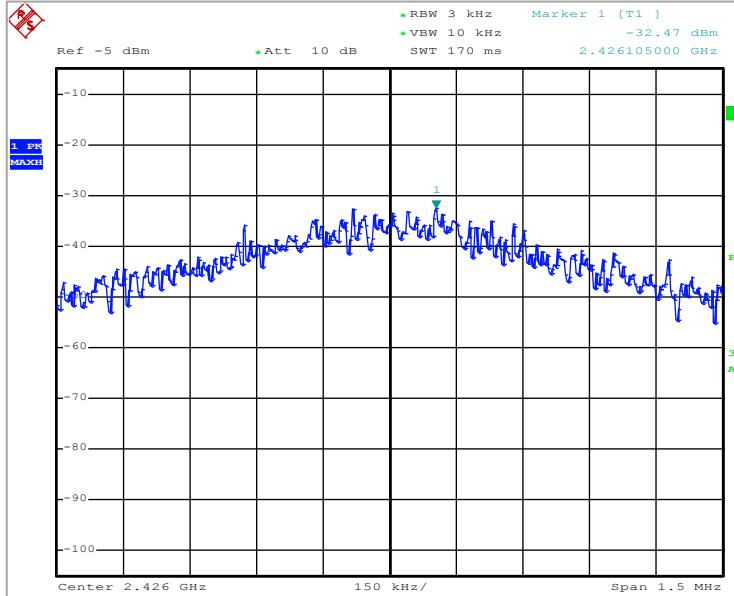
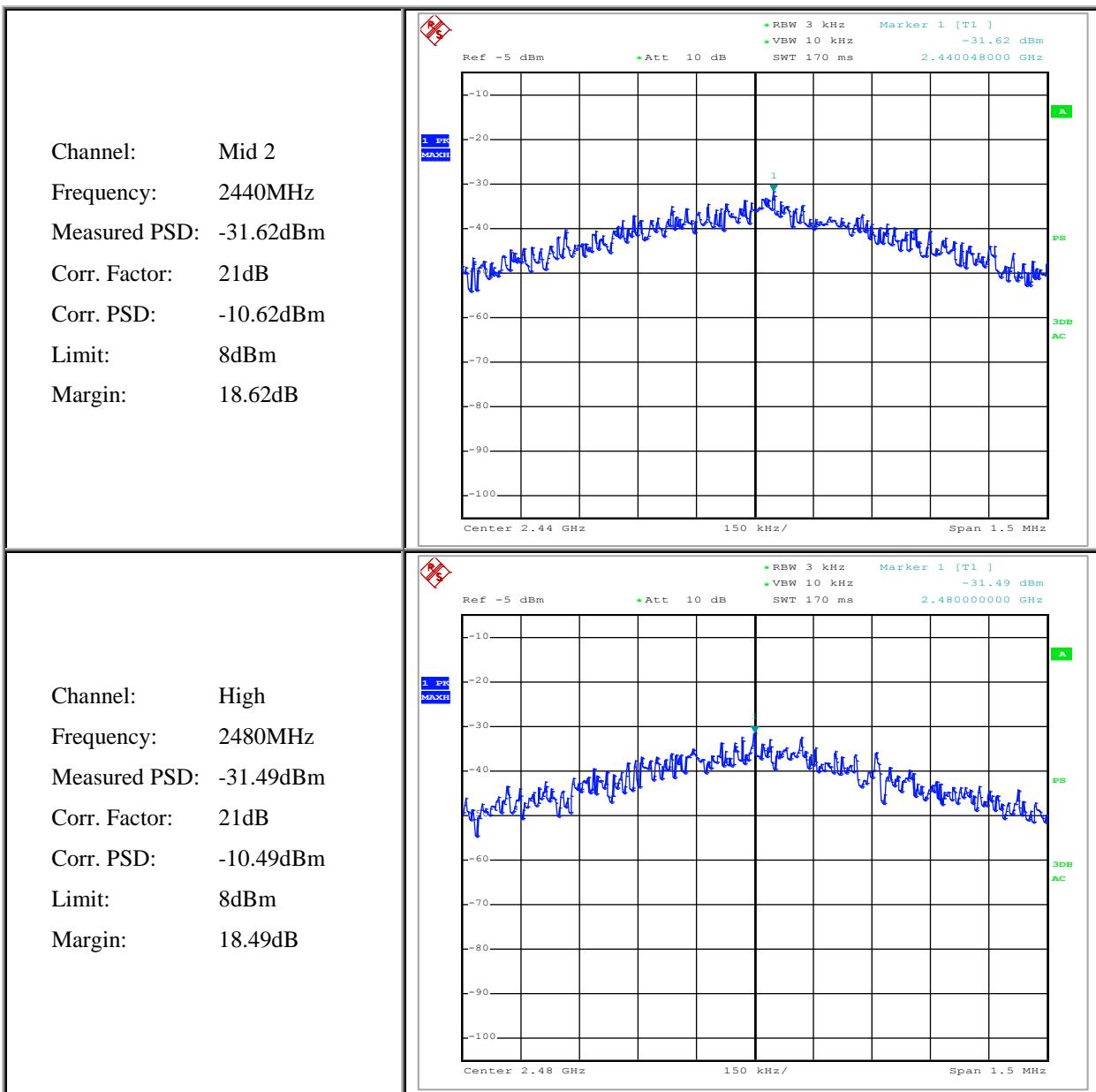


Table 10: Power Spectral Density Measurement – 2MBPS

Result Measurement	Plot
Channel: Low Frequency: 2402MHz Measured PSD: -31.88dBm Corr. Factor: 21dB Corr. PSD: -10.88dBm Limit: 8dBm Margin: 18.88dB	 <p>Ref -5 dBm Att 10 dB SWT 170 ms Center 2.402 GHz Span 1.5 MHz</p> <p>RBW 3 kHz Marker 1 [T1] -31.88 dBm VBW 10 kHz 2.401949000 GHz</p> <p>A PS 3dB AC</p>
Channel: Mid 1 Frequency: 2426MHz Measured PSD: -32.47dBm Corr. Factor: 21dB Corr. PSD: -11.47dBm Limit: 8dBm Margin: 19.47dB	 <p>Ref -5 dBm Att 10 dB SWT 170 ms Center 2.426 GHz Span 1.5 MHz</p> <p>RBW 3 kHz Marker 1 [T1] -32.47 dBm VBW 10 kHz 2.426105000 GHz</p> <p>A PS 3dB AC</p>



3.6 Out of Band Emissions Band Edge

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (d)
- RSS-247 Issue 1: Clause 5.5

Test Method:

- ANSI C63.10:2013

Test Requirement:

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20dB. Attenuation below the general field strength limits specified in RSS-Gen Issue 4 is not required.

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

Measurement Method:

The measurement method used was Section 6.10.6.2 Marker-delta Method of ANSI C63.10-2013 standard.

Modifications:

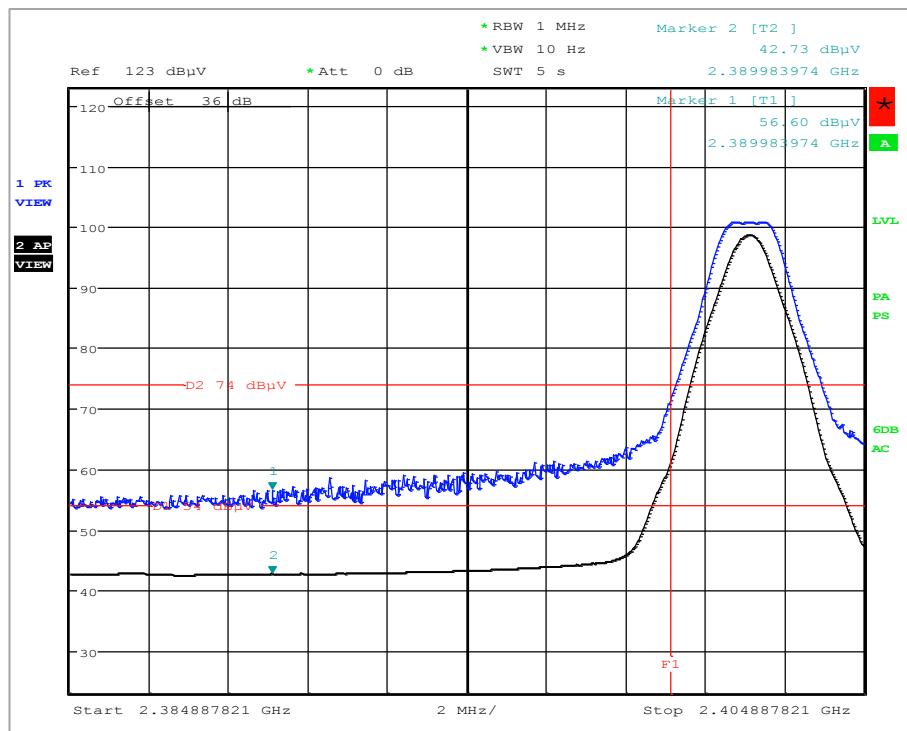
No modification was required to comply for this test.

Result:

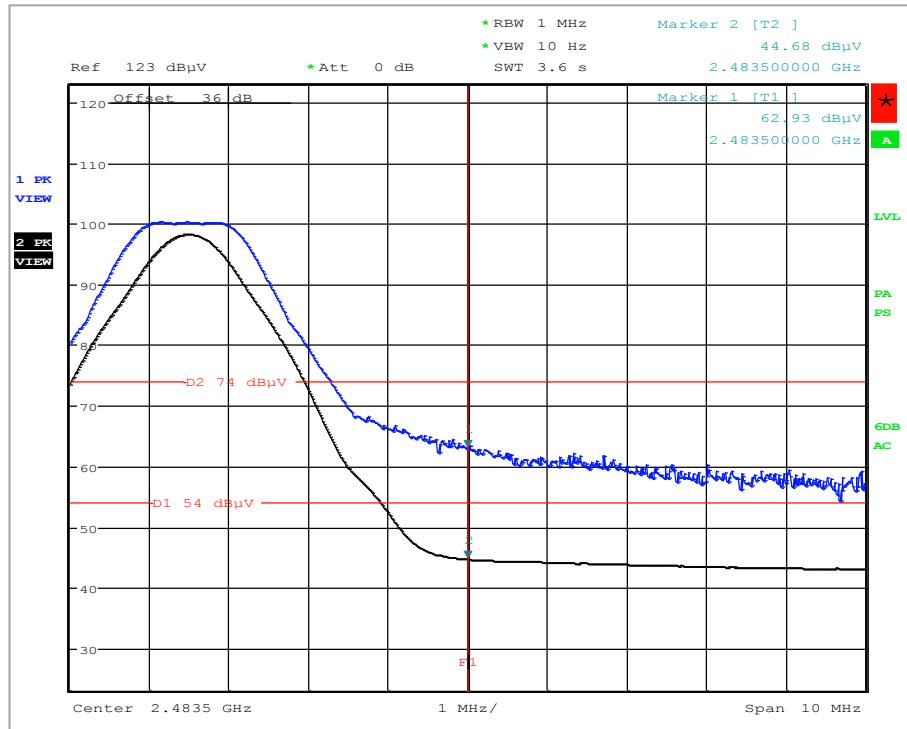
The EUT complies with the applicable standard.

Measurement Data and Plot:

Radiated Band Edge 3m:



Plot 1: Radiated Band Edge Plot – Low Side



Plot 2: Radiated Band Edge Plot – High Side

3.7 Conducted Spurious Emissions

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.247 (d)
- RSS-247 Issue 1: Clause 5.5

Test Method:

- ANSI C63.10:2013

Test Requirement:

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

Test Setup:

The antenna port of EUT was directly connected to a spectrum analyzer.

Modifications:

No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

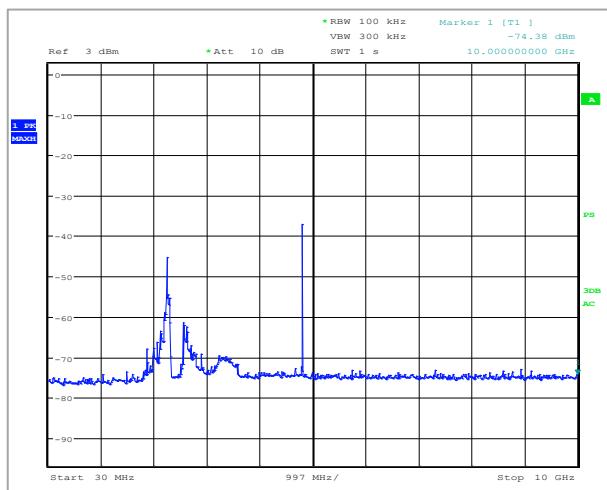
Remark:

A special antenna was provided in the internal circuitry of the EUT by the client and was only used for conducted peak power output measurements.

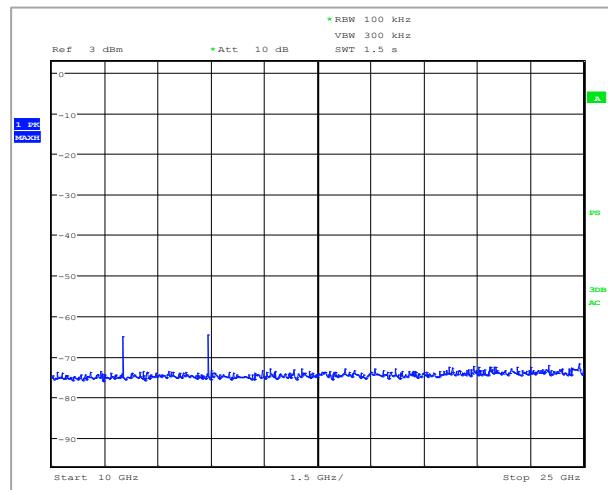
Measurement Data and Plot:

Table 11: Conducted Spurious Emissions Data – Low Channel ~ 1MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
Low Channel 2402MHz	4804	-35.93	2.26	-33.67	-17.5	16.17
	7206	noise floor	2.44	noise floor	-17.5	-
	9608	noise floor	3.91	noise floor	-17.5	-
	12010	-62.64	4.74	-57.9	-17.5	40.4
	14412	-62.46	8.76	-53.7	-17.5	36.2
	16814	-71.59	8.53	-63.06	-17.5	45.56



Frequency Span: 30MHz ↔ 10GHz

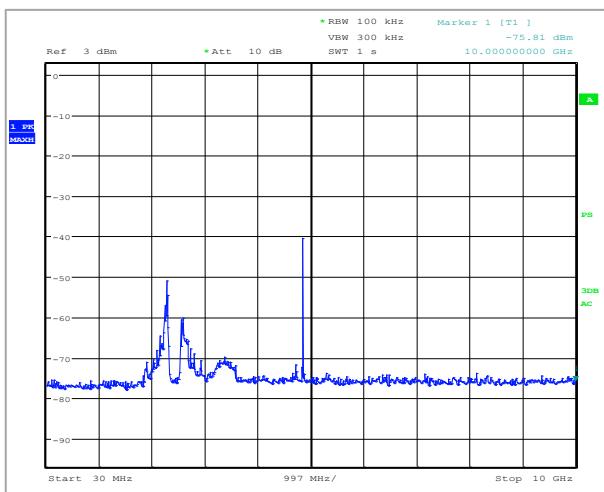


Frequency Span: 10GHz ↔ 25GHz

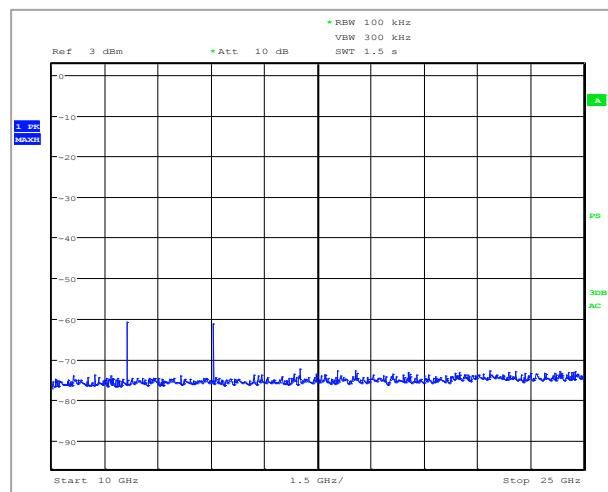
Plot 3: Conducted Spurious Emissions Plot – Low Channel ~ 1MBPS

Table 12: Conducted Spurious Emissions Data – Mid 1 Channel ~ 1MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
Mid 1 Channel 2426MHz	4852	-37.46	2.84	-34.62	-17.43	17.19
	7278	noise floor	3.12	noise floor	-17.43	-
	9704	noise floor	4.73	noise floor	-17.43	-
	12130	-56.75	4.69	-52.06	-17.43	34.63
	14556	-58.84	9.36	-49.48	-17.43	32.05
	16982	-70.18	8.58	-61.6	-17.43	44.17



Frequency Span: 30MHz ↔ 10GHz

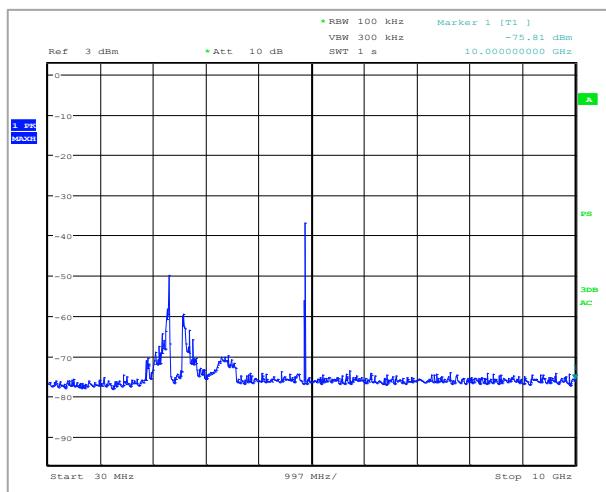


Frequency Span: 10GHz ↔ 25GHz

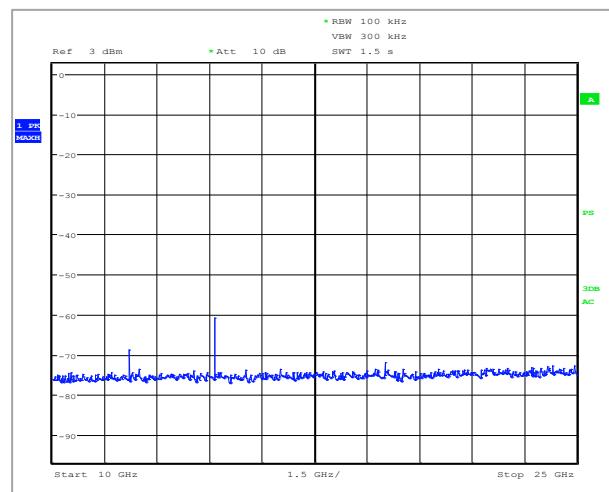
Plot 4: Conducted Spurious Emissions Plot – Mid 1 Channel ~ 1MBPS

Table 13: Conducted Spurious Emissions Data – Mid 2 Channel ~ 1MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
Mid 2 Channel 2440MHz	4880	-35.83	2.84	-32.99	-17.43	15.56
	7320	noise floor	3.12	noise floor	-17.43	-
	9760	noise floor	4.73	noise floor	-17.43	-
	12200	-62.6	4.69	-57.91	-17.43	40.48
	14640	-58.63	9.36	-49.27	-17.43	31.84
	17080	-69.69	8.58	-61.11	-17.43	43.68



Frequency Span: 30MHz ↔ 10GHz

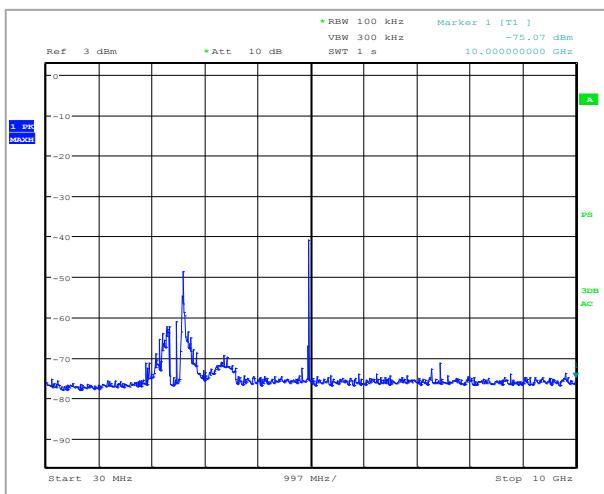


Frequency Span: 10GHz ↔ 25GHz

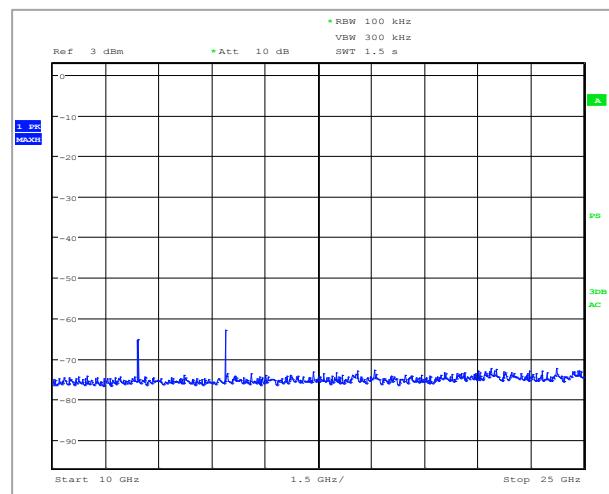
Plot 5: Conducted Spurious Emissions Plot – Mid 2 Channel ~ 1MBPS

Table 14: Conducted Spurious Emissions Data – High Channel ~ 1MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
High Channel 2480MHz	4960	-40.62	2.23	-38.39	-17.65	20.74
	7440	noise floor	3.15	noise floor	-17.65	-
	9920	noise floor	4.46	noise floor	-17.65	-
	12400	-62.85	4.65	-58.2	-17.65	40.55
	14880	-60.17	8.54	-51.63	-17.65	33.98
	17360	-71.24	7.74	-63.5	-17.65	45.85



Frequency Span: 30MHz ↔ 10GHz

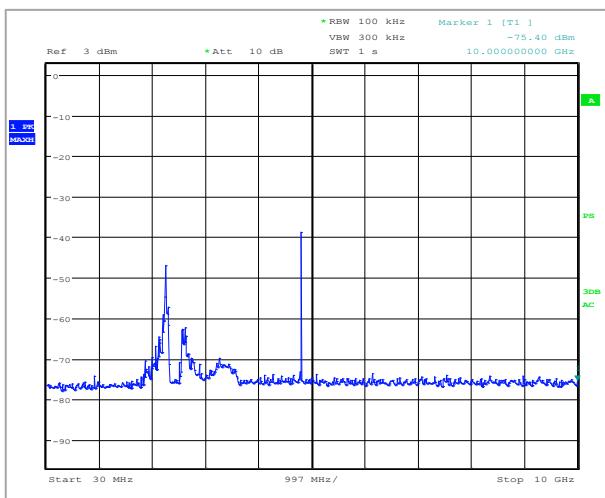


Frequency Span: 10GHz ↔ 25GHz

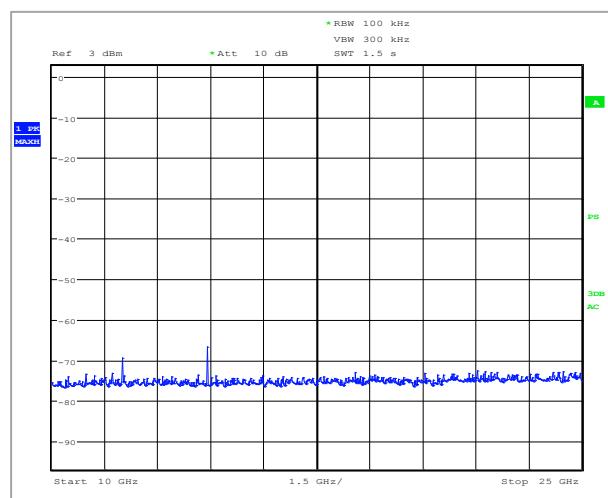
Plot 6: Conducted Spurious Emissions Plot – High Channel ~ 1MBPS

Table 15: Conducted Spurious Emissions Data – Low Channel ~ 2MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
Low Channel 2402MHz	4804	-35.85	2.26	-33.59	-17.5	16.09
	7206	noise floor	2.44	noise floor	-17.5	-
	9608	noise floor	3.91	noise floor	-17.5	-
	12010	-62.59	4.74	-57.85	-17.5	40.35
	14412	-62.62	8.76	-53.86	-17.5	36.36
	16814	-71.52	8.53	-62.99	-17.5	45.49



Frequency Span: 30MHz ↔ 10GHz

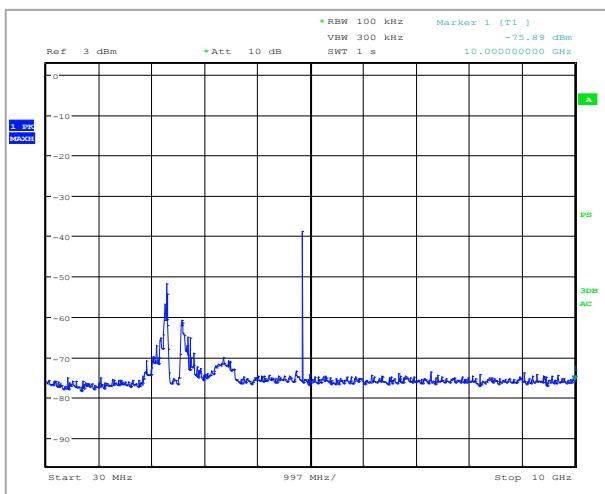


Frequency Span: 10GHz ↔ 25GHz

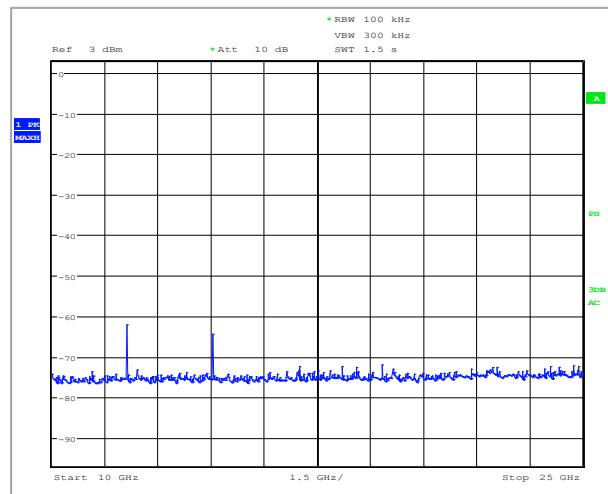
Plot 7: Conducted Spurious Emissions Plot – Low Channel ~ 2MBPS

Table 16: Conducted Spurious Emissions Data – Mid 1 Channel ~ 2MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
Mid 1 Channel 2426MHz	4852	-37.42	2.84	-34.58	-17.43	17.15
	7278	noise floor	3.12	noise floor	-17.43	-
	9704	noise floor	4.73	noise floor	-17.43	-
	12130	-56.36	4.69	-51.67	-17.43	34.24
	14556	-58.9	9.36	-49.54	-17.43	32.11
	16982	-69.81	8.58	-61.23	-17.43	43.8



Frequency Span: 30MHz ↔ 10GHz

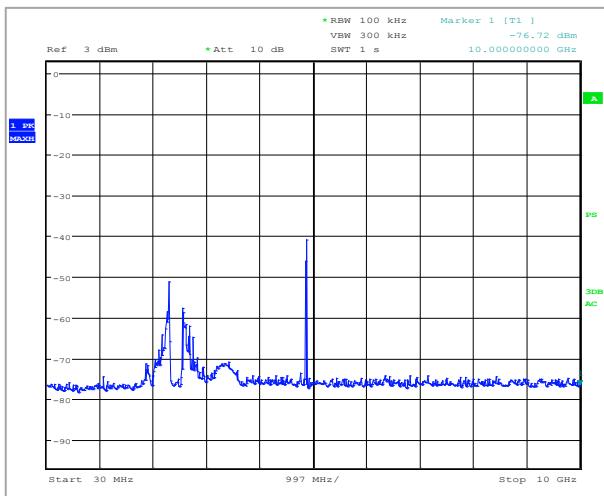


Frequency Span: 10GHz ↔ 25GHz

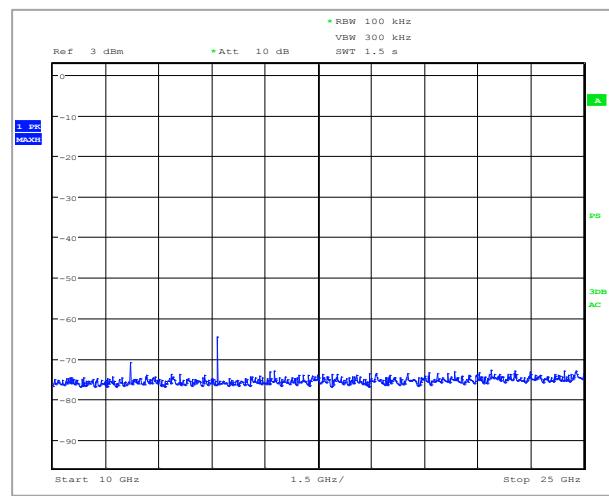
Plot 8: Conducted Spurious Emissions Plot – Mid 1 Channel ~ 2MBPS

Table 17: Conducted Spurious Emissions Data – Mid 2 Channel ~ 2MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
Mid 2 Channel 2440MHz	4880	-35.77	2.84	-32.93	-17.43	15.5
	7320	noise floor	3.12	noise floor	-17.43	-
	9760	noise floor	4.73	noise floor	-17.43	-
	12200	-63.49	4.69	-58.8	-17.43	41.37
	14640	-59.11	9.36	-49.75	-17.43	32.32
	17080	-70.03	8.58	-61.45	-17.43	44.02



Frequency Span: 30MHz ↔ 10GHz

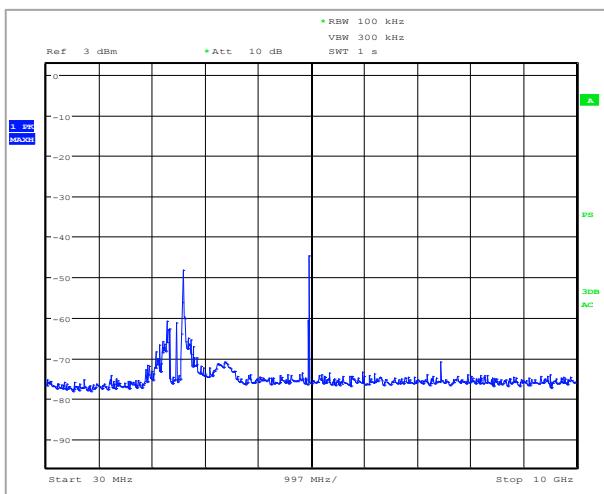


Frequency Span: 10GHz ↔ 25GHz

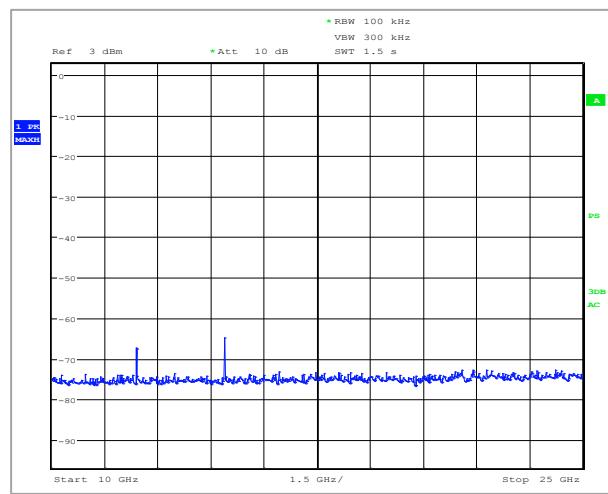
Plot 9: Conducted Spurious Emissions Plot – Mid 2 Channel ~ 2MBPS

Table 18: Conducted Spurious Emissions Data – High Channel ~ 2MBPS

Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Loss (dB)	Corrected Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
High Channel 2480MHz	4960	-40.49	2.23	-38.26	-17.65	20.61
	7440	noise floor	3.15	noise floor	-17.65	-
	9920	noise floor	4.46	noise floor	-17.65	-
	12400	-62.46	4.65	-57.81	-17.65	40.16
	14880	-59.64	8.54	-51.1	-17.65	33.45
	17360	-70.29	7.74	-62.55	-17.65	44.9



Frequency Span: 30MHz ↔ 10GHz



Frequency Span: 10GHz ↔ 25GHz

Plot 10: Conducted Spurious Emissions Plot – High Channel ~ 2MBPS

3.8 Radiated Spurious Emissions ~ Transmit Mode

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.209
- FCC Title 47 CFR Part 15: Subpart C §15.205
- RSS-Gen Issue 4: Clause 8.9 and 8.10

Test Method:

- ANSI C63.10:2013

Test Requirement:

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or to the general field strength limits listed in Rss-Gen Issue 4, whichever is less stringent.

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency if the equipment operates below 10 GHz; to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
Unwanted emissions falling into restricted bands of shall comply with the limits specified below

Frequency (MHz)	Field Strength (dB μ V/m) at 3m
0.009 – 0.490	128.5 – 93.8
0.490 – 1.705	73.8 – 63.0
1.705 – 30.0	69.5

Frequency (MHz)	Field Strength Quasi Peak dB μ V/m @ 3m
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
Above 960	54.0

FCC PART 15.205-RESTRICTED BANDS OF OPERATION

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(²)
13.36-13.41			

* - note FCC-specific .

Canada-specific frequency ranges in MHz – 3.020-3.026, 5.677–5.683, 121.94-123.0, 149.9-150.05, 162.0125-167.17, 167.72-173.2, 1300-1427, 2483.5-2500, 3500-3600,

(2) Above 38,6 GHz

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies, equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

RESTRICTED FREQUENCY BANDS (RSS-GEN ISSUE 4)

MHz	MHz	GHz
0.090-0.110	240-285	9.0-9.2
2.1735-2.1905	322-335.4	9.3-9.5
3.020-3.026	399.9-410	10.6-12.7
4.125-4.128	608-614	13.25-13.4
4.17725-4.17775	960-1427	14.47-14.5
4.20725-4.20775	1435-1626.5	15.35-16.2
5.677-5.683	1645.5-1646.5	17.7-21.4
6.215-6.218	1660-1710	22.01-23.12
6.26775-6.26825	1718.8-1722.2	23.6-24.0
6.31175-6.31225	2200-2300	31.2-31.8
8.291-8.294	2310-2390	36.43-36.5
8.362-8.366	2655-2900	Above 38.6
8.37625-8.38675	3260-3267	
8.41425-8.41475	3332-3339	
12.29-12.293	3345.8-3358	
12.51975-12.52025	3500-4400	
12.57675-12.57725	4500-5150	
13.36-13.41	5350-5460	
16.42-16.423	7250-7750	
16.69475-16.69525	8025-8500	
16.80425-16.80475		
25.5-25.67		
37.5-38.25		
73-74.6		
74.8-75.2		
108-138		
156.52475-156.52525		
156.7-156.9		

Note: Certain frequency bands listed in Table 3 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in the 200- and 300-series RSSs, such as RSS-210 and RSS-310, which contain the requirements that apply to licence-exempt radio apparatus.

Test Setup:

The EUT was tested in our 3 m SAC and was positioned on the center of the turntable. The transmitter was set for continuous transmission. The lowest, middle and highest channels in the 2400-2483.5 MHz bands were measured for all radiated emissions 10kHz to 18 GHz and above 18GHz up to the 10th harmonic of the highest fundamental frequency, which is 24.80 GHz. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed flat on the table top as indicated in the test photos.

Measurement Method:

ANSI C63.4:2014 radiated emissions procedure was followed to demonstrate the compliance of EUT.

Modifications:

No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Table 19: Fundamental Field Strength Data – 1MBPS

Channel	Unit Position	Raw Peak	Raw Average	Ant. Pol.	Turn Table.	Ant. Height	Ant. Factor	System Loss/Gain	Corr. Peak	Corr. Average
		(dB μ V/m)	(dB μ V/m)	(V or H)	(°)	(cm)	(dB/m)	(dB)	(dB μ V/m)	(dB μ V/m)
Low 2402MHz	Flat	54.17	49	V	294	103.6	32.5	3.4	90.07	84.9
		65.91	64.6	H	263	108.1	32.5	3.4	101.81	100.5
	Stand	65.28	64	V	231.9	103.1	32.5	3.4	101.18	99.9
		58.66	57.2	H	149.7	227	32.5	3.4	94.56	93.1
Mid 2426MHz	Flat	53.4	51.5	V	357.2	125.8	32.5	3.3	89.2	87.3
		65.73	64.5	H	146	127.9	32.5	3.3	101.53	100.3
	Stand	55.3	53.5	V	16.3	145.3	32.5	3.3	91.1	89.3
		64.23	63	H	21	139.3	32.5	3.3	100.03	98.8
High 2480MHz	Flat	52.02	49.7	V	352.7	100	32.5	3.5	88.02	85.7
		65.44	64.2	H	135.2	117.6	32.5	3.5	101.44	100.2
	Stand	56.76	55.3	V	32.3	254	32.5	3.5	92.76	91.3
		64.47	64.2	H	168..5	119.6	32.5	3.5	100.47	100.2

Table 20: Fundamental Field Strength Data – 2MBPS

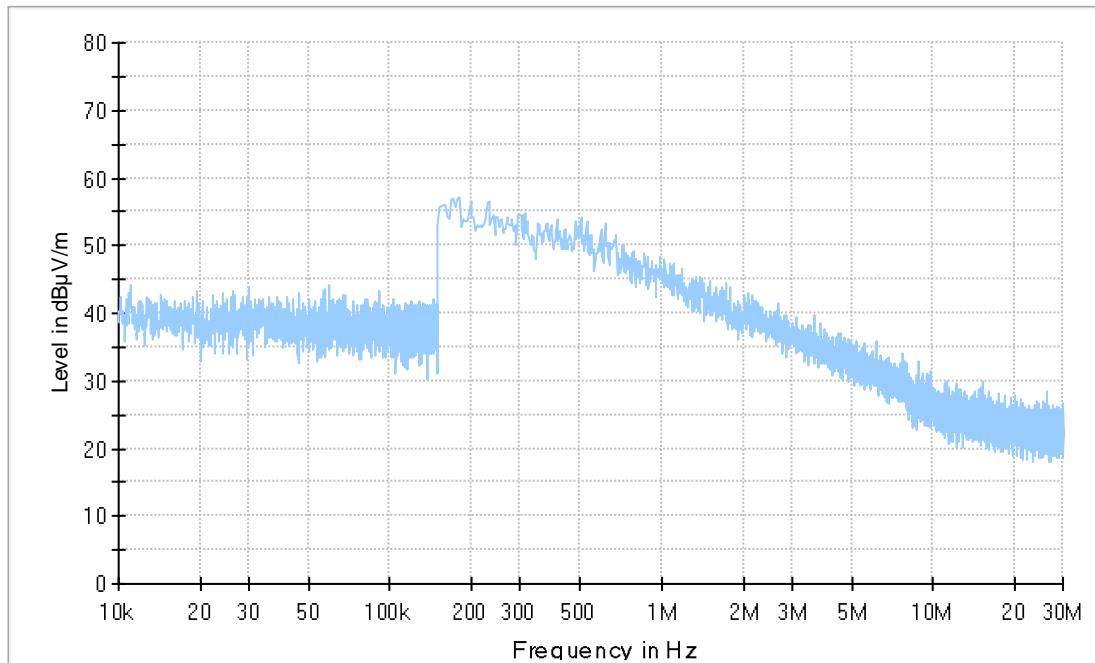
Channel	Unit Position	Raw Peak	Raw Average	Ant. Pol.	Turn Table.	Ant. Height	Ant. Factor	System Loss/Gain	Corr. Peak	Corr. Average
		(dB μ V/m)	(dB μ V/m)	(V or H)	(°)	(cm)	(dB/m)	(dB)	(dB μ V/m)	(dB μ V/m)
Low 2402MHz	Flat	60.7	58.1	V	70	220	32.5	3.4	96.6	94
		63.6	61.03	H	340	134	32.5	3.4	99.5	96.93
	Stand	63.9	61.3	V	300	150	32.5	3.4	99.8	97.2
		58.2	55.7	H	149.7	227	32.5	3.4	94.1	91.6
Mid 2426MHz	Flat	60.7	58	V	45	310	32.5	3.3	96.5	93.8
		64.7	62.1	H	120	130	32.5	3.3	100.5	97.9
	Stand	61.2	58.6	V	0	300	32.5	3.3	97	94.4
		57.1	54.5	H	160	245	32.5	3.3	92.9	90.3
High 2480MHz	Flat	60.6	58	V	54	335	32.5	3.5	96.6	94
		63.6	61.1	H	113	143	32.5	3.5	99.6	97.1
	Stand	61.1	58.6	V	336	207	32.5	3.5	97.1	94.6
		57.8	55.2	H	140	280	32.5	3.5	93.8	91.2

EUT Test Mode:

- Low Channel ~ 2402MHz

Frequency Range:

- 10kHz to 30MHz



Plot 11: Radiated Emissions scanned at 3m SAC

Remark:

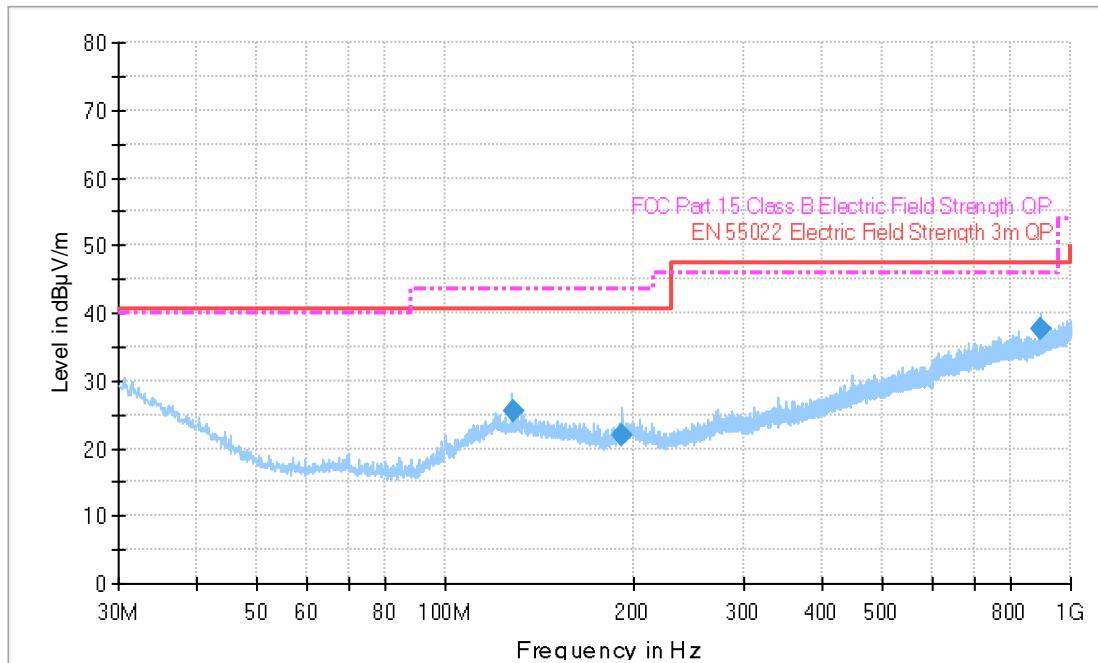
- Data were 20dB and greater below the limit line and need not to be reported. -FCC Part 15.31 (o)

EUT Test Mode:

- Low Channel ~ 2402MHz

Frequency Range:

- 30MHz to 1GHz



Plot 12: Radiated Emissions scanned at 3m SAC

Table 21: QPeak Data of Radiated Emissions measured 3m SAC

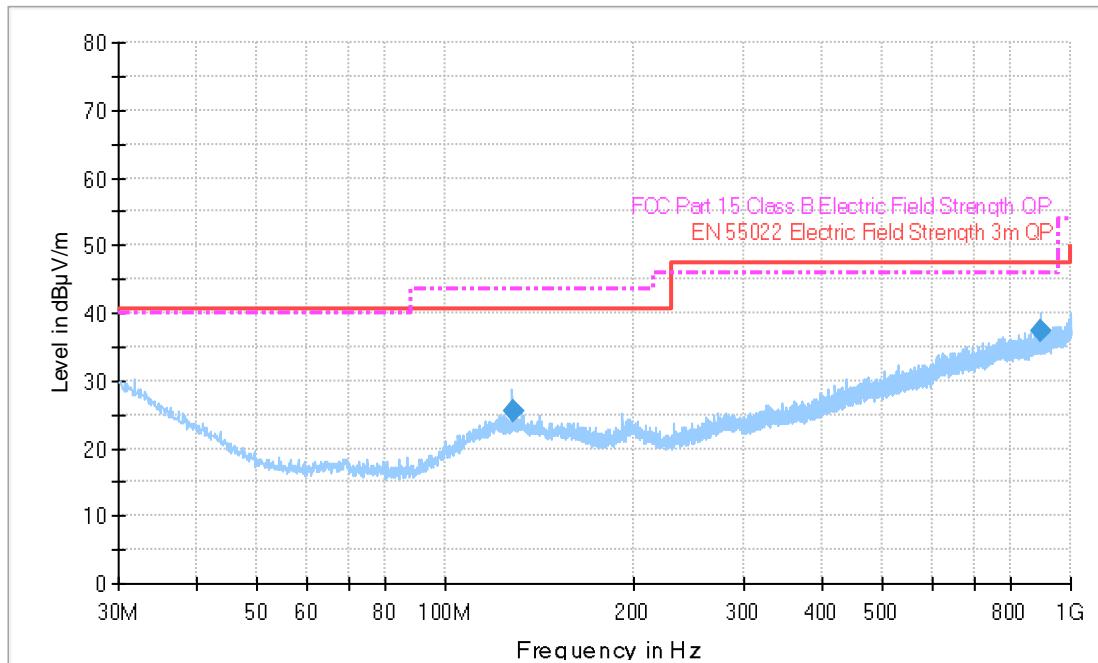
Freq. (MHz)	QPeak (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB μ V/m)
128.003120	25.3	1000.000	120.000	303.0	V	0.0	20.6	18.2	43.5
192.027680	21.9	1000.000	120.000	400.0	H	174.0	18.7	21.6	43.5
896.003800	37.5	1000.000	120.000	285.0	H	225.0	30.5	8.5	46.0

EUT Test Mode:

- Mid Channel ~ 2426MHz

Frequency Range:

- 30MHz to 1GHz



Plot 13: Radiated Emissions scanned at 3m SAC

Table 22: QPeak Data of Radiated Emissions measured 3m SAC

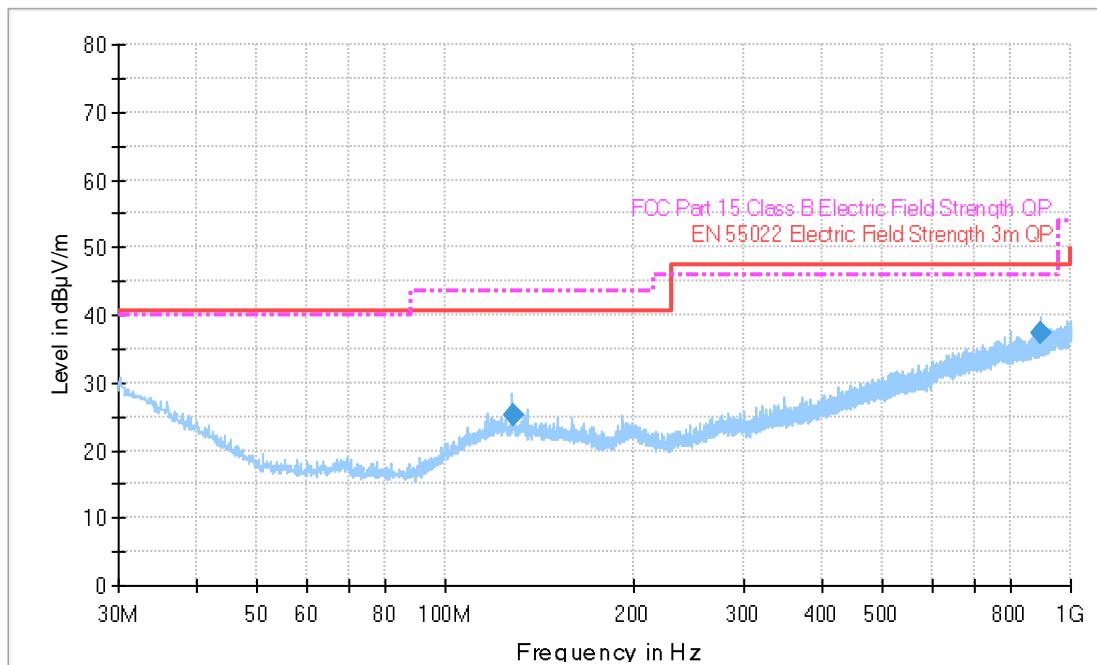
Freq. (MHz)	QPeak (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB μ V/m)
128.007440	25.5	1000.000	120.000	230.0	V	186.0	20.6	18	43.5
896.014080	37.3	1000.000	120.000	297.0	V	161.0	30.5	8.7	46.0

EUT Test Mode:

- High Channel ~ 2480MHz

Frequency Range:

- 30MHz to 1GHz



Plot 14: Radiated Emissions scanned at 3m SAC

Table 23: QPeak Data of Radiated Emissions measured 3m SAC

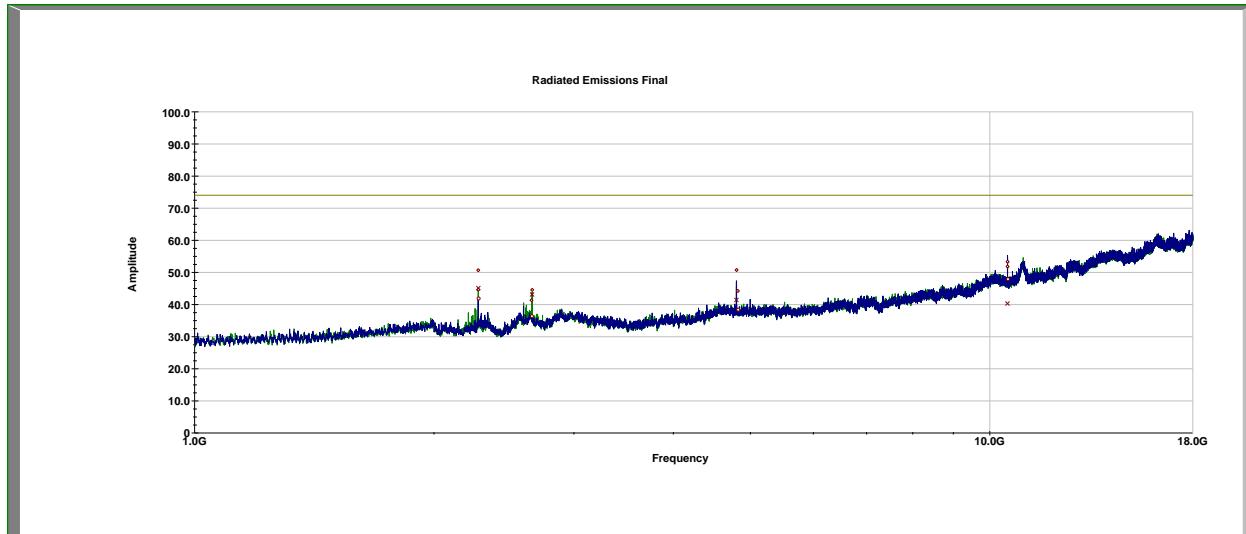
Freq. (MHz)	QPeak (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB μ V/m)
127.988000	25.1	1000.000	120.000	350.0	H	79.0	20.6	18.4	43.5
896.005680	37.5	1000.000	120.000	272.0	V	139.0	30.5	8.5	46.0

EUT Test Mode:

- Low Channel ~ 2402MHz ~ 1MBPS

Frequency Range:

- 1GHz to 18GHz



Plot 15: Radiated Emissions scanned at 3m SAC

Table 24: Average and Peak Data of Radiated Emissions at high frequency measured 3m SAC

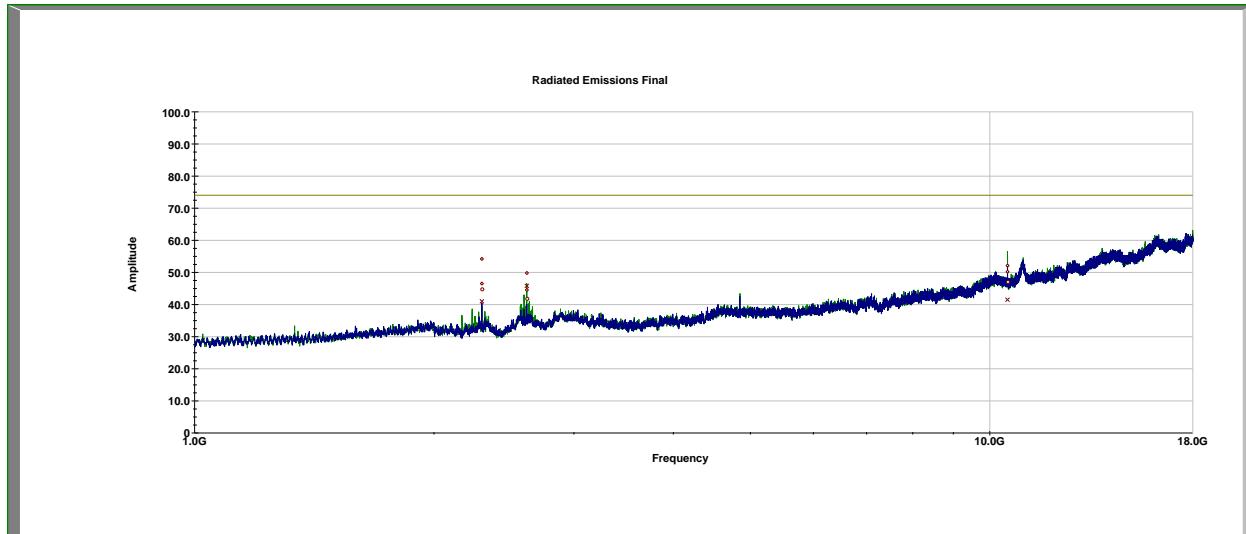
Freq.	Average	Peak	Ant. Ht.	Ant. Pol.	Turn Table Position	H Corr.	V Corr.	Average Limit	Average Margin	Peak Limit	Peak Margin
MHz	dB μ V/m	dB μ V/m	cm		deg	dB	dB	dB μ V/m	dB	dB μ V/m	dB
2273.926	41.989	44.574	149	V	219	-0.626	-0.626	54	12.011	74	29.426
2653.142	36.469	41.351	276	V	249	0.751	0.751	54	17.531	74	32.649
4822.002	38.5	44.225	221	V	99	5.925	5.925	54	15.5	74	29.775
10527.99	48.016	53.306	282	V	360	15.006	15.006	54	5.984	74	20.694

EUT Test Mode:

- Mid Channel ~ 2426MHz ~ 1MBPS

Frequency Range:

- 1GHz to 18GHz



Plot 16: Radiated Emissions scanned at 3m SAC

Table 25: Average and Peak Data of Radiated Emissions at high frequency measured 3m SAC

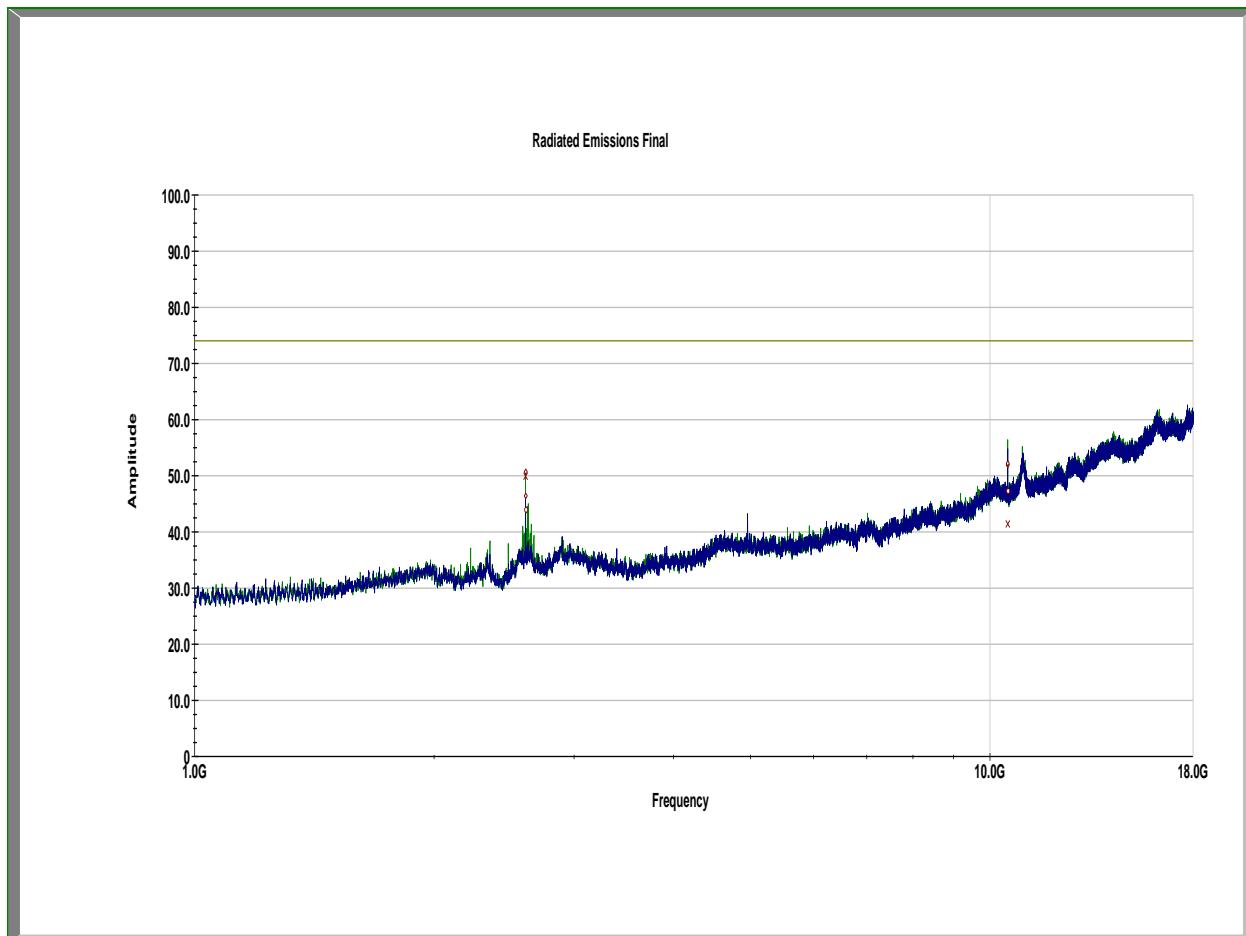
Freq.	Average	Peak	Ant. Ht.	Ant. Pol.	Turn Table Position	H Corr.	V Corr.	Average Limit	Average Margin	Peak Limit	Peak Margin
MHz	dB μ V/m	dB μ V/m	cm		deg	dB	dB	dB μ V/m	dB	dB μ V/m	dB
2298.023	44.839	46.506	300	V	357	-0.494	-0.494	54	9.161	74	27.494
2617.971	41.88	44.52	300	V	75	0.72	0.72	54	12.12	74	29.48
10528.02	47.103	50.206	230	V	249	15.006	15.006	54	6.897	74	23.794

EUT Test Mode:

- High Channel ~ 2480MHz ~ 1MBPS

Frequency Range:

- 1GHz to 18GHz



Plot 17: Radiated Emissions scanned at 3m SAC

Table 26: Average and Peak Data of Radiated Emissions at high frequency measured 3m SAC

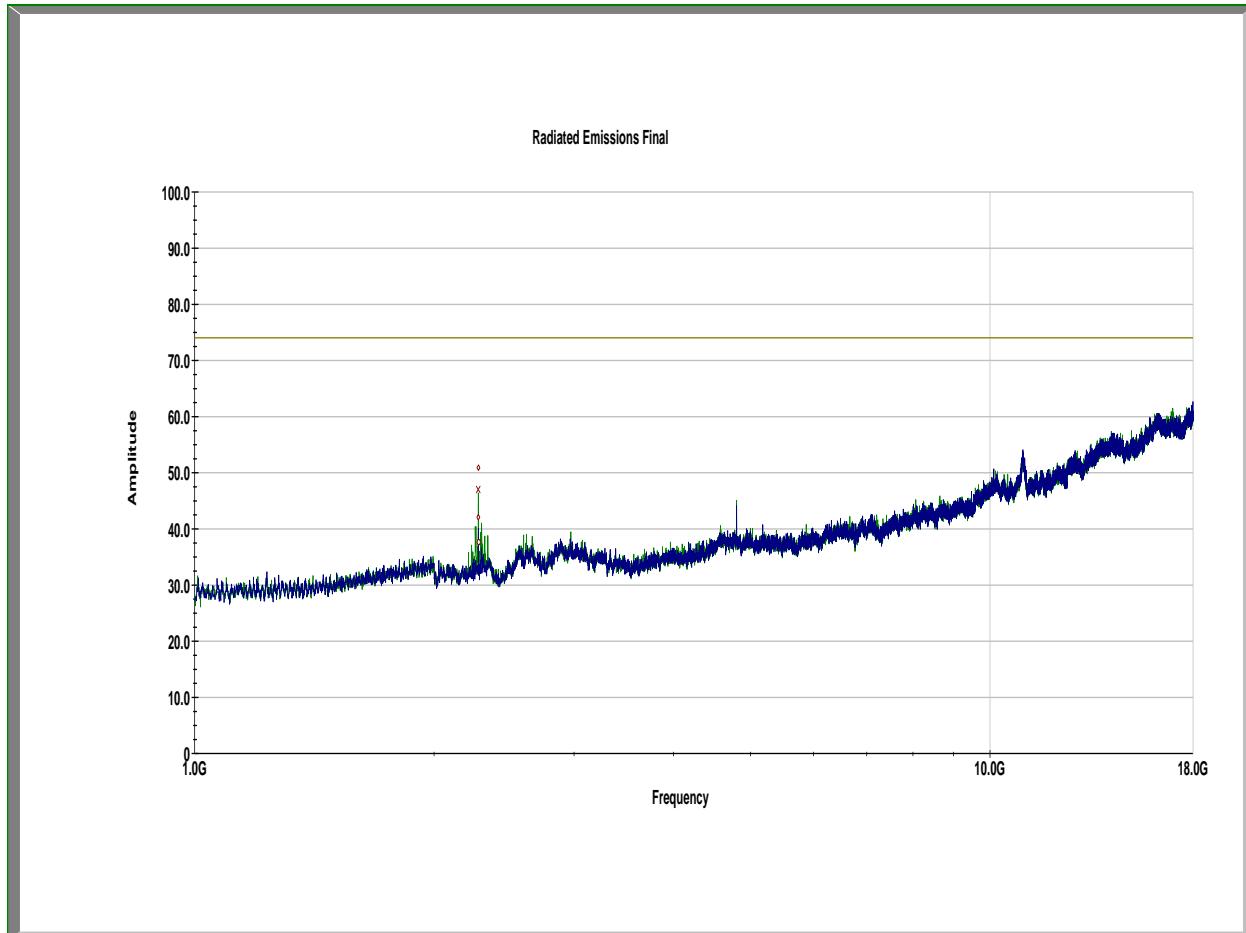
Freq.	Average	Peak	Ant. Ht.	Ant. Pol.	Turn Table Position	H Corr.	V Corr.	Average Limit	Average Margin	Peak Limit	Peak Margin
MHz	dB μ V/m	dB μ V/m	cm		deg	dB	dB	dB μ V/m	dB	dB μ V/m	dB
2607.947	44.024	46.412	127.000		317.000	0.712	0.712	54	9.976	74	27.588
10527.981	47.386	51.906	119.000	V	348.000	15.006	15.006	54	6.614	74	22.094

EUT Test Mode:

- Low Channel ~ 2402MHz ~ 2MBPS

Frequency Range:

- 1GHz to 18GHz



Plot 18: Radiated Emissions scanned at 3m SAC

Table 27: Average and Peak Data of Radiated Emissions at high frequency measured 3m SAC

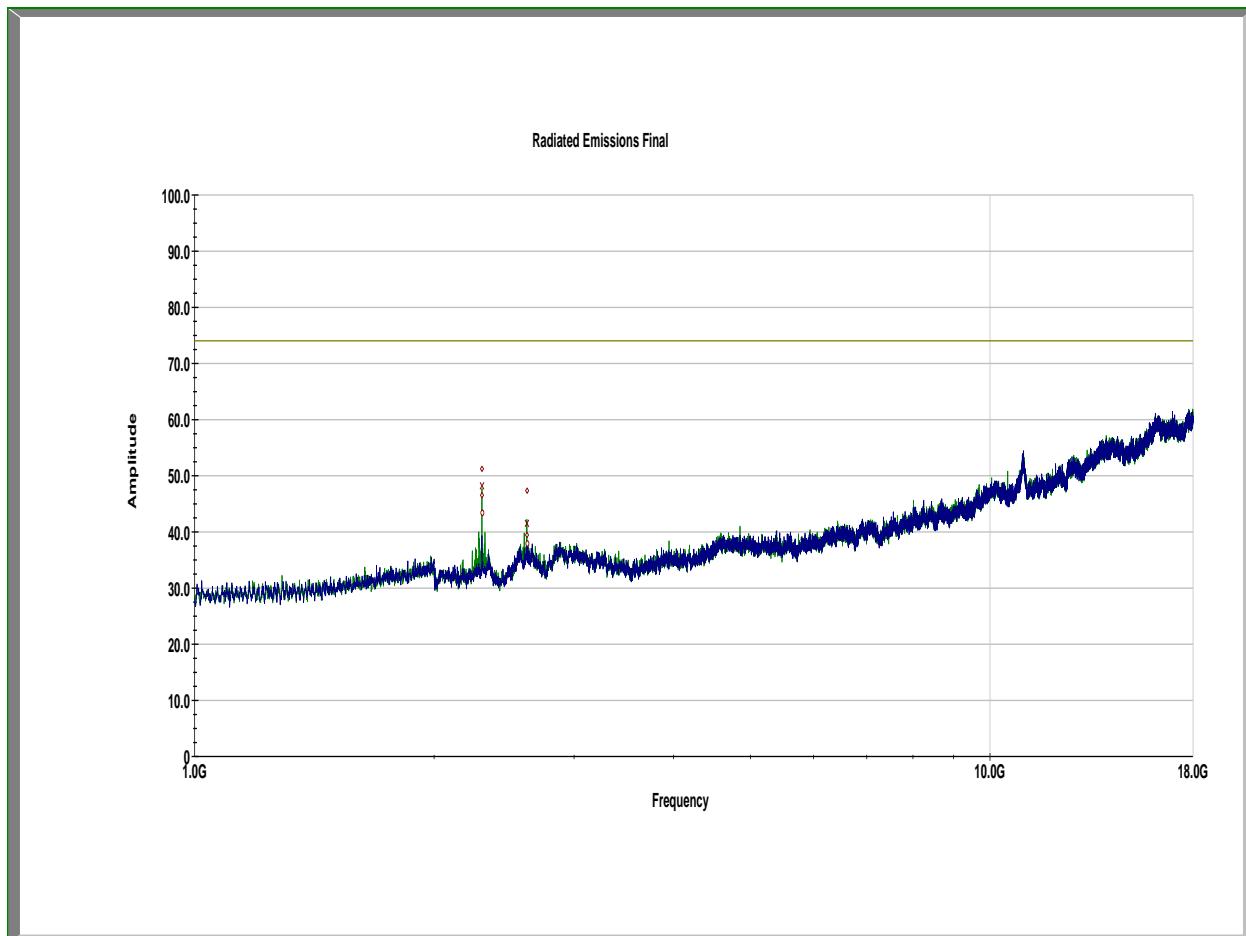
Freq.	Average	Peak	Ant. Ht.	Ant. Pol.	Turn Table Position	H Corr.	V Corr.	Average Limit	Average Margin	Peak Limit	Peak Margin
MHz	dB μ V/m	dB μ V/m	cm		deg	dB	dB	dB μ V/m	dB	dB μ V/m	dB
2273.957	37.762	42.074	107.000	V	245.000	-0.626	-0.626	54	16.238	74	31.926

EUT Test Mode:

- Mid Channel ~ 2426MHz ~ 2MBPS

Frequency Range:

- 1GHz to 18GHz



Plot 19: Radiated Emissions scanned at 3m SAC

Table 28: Average and Peak Data of Radiated Emissions at high frequency measured 3m SAC

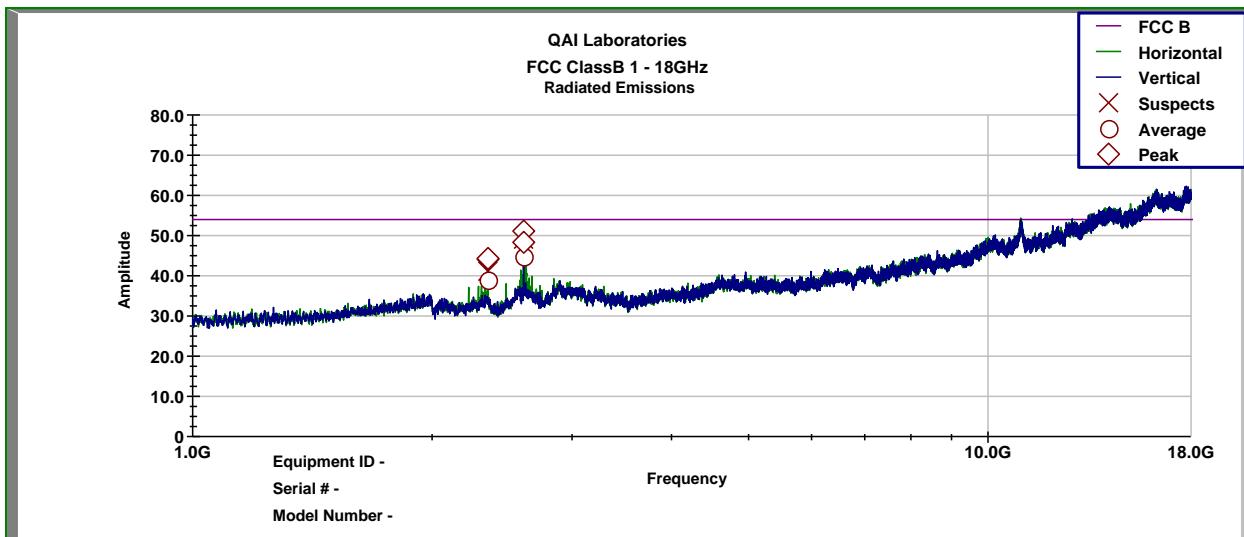
Freq.	Average	Peak	Ant. Ht.	Ant. Pol.	Turn Table Position	H Corr.	V Corr.	Average Limit	Average Margin	Peak Limit	Peak Margin
MHz	dB μ V/m	dB μ V/m	cm		deg	dB	dB	dB μ V/m	dB	dB μ V/m	dB
2297.895	43.501	46.506	274.000	V	27.000	-0.494	-0.494	54	10.499	74	27.494
2617.848	38.018	39.420	191.000	V	3.000	0.720	0.720	54	15.982	74	34.58

EUT Test Mode:

- High Channel ~ 2480MHz ~ 2MBPS

Frequency Range:

- 1GHz to 18GHz



Plot 20: Radiated Emissions scanned at 3m SAC

Table 29: Average and Peak Data of Radiated Emissions at high frequency measured 3m SAC

Freq.	Average	Peak	Ant. Ht.	Ant. Pol.	Turn Table Position	H Corr.	V Corr.	Average Limit	Average Margin	Peak Limit	Peak Margin
MHz	dB μ V/m	dB μ V/m	cm		deg	dB	dB	dB μ V/m	dB	dB μ V/m	dB
2351.933	38.948	44.303	246	V	41	-0.197	-0.197	54	15.052	74	29.697
2607.992	44.777	48.312	198	V	0	0.712	0.712	54	9.223	74	25.688

3.9 Radiated Emissions ~ Receive Mode

Date Performed:

March 9, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart B §15.109
- ICES-003 Issue 6: Clause 6.2
- RSS-Gen Issue 4: Clause 7.1

Test Method:

- ANSI C63.4-2014

Test Requirement:

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20 dB below the level of the fundamental or to the general field strength limits listed in RSS-Gen Issue 4, whichever is less stringent.

In measuring unwanted emissions, the spectrum shall be investigated from 30 MHz or the lowest radio frequency signal generated in the equipment, whichever is lower, without going below 9 kHz, up to at least the frequency if the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Unwanted emissions falling into restricted bands of shall comply with the limits specified below

Frequency (MHz)	Field Strength Quasi Peak dB μ V/m @ 3m
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
Above 960	54.0

Test Setup:

The EUT was tested in our 3 m SAC and was positioned on the center of the turntable. The transmitter was set for continuous transmission. The lowest, middle and highest channels in the 2400-2483.5 MHz band were measured for all radiated emissions 10kHz to 18 GHz. The EUT was pre-scanned in 3 different orthogonal orientations and was found to radiate highest when placed flat on the table top as indicated in the test photos.

Measurement Method:

Measurements were made using spectrum analyser and receiver, 200Hz RBW average detector for the frequency range 9-150KHz; 9kHz RBW average detector for the Frequency range 150kHz to 30MHz; 120kHz RBW quasi-peak detector using the appropriate antennas, amplifiers and filters.

The measurement results are obtained as described below:

$$E [\text{dB}\mu\text{V}/\text{m}] = \text{Un-Corrected Value} + ATOT$$

Where ATOT is total correction factor including cable loss, antenna factor and preamplifier gain (ATOT = LCABLES + AF - AMP).

Modifications:

No modification was required to comply for this test.

Result:

The EUT complies with the applicable standard.

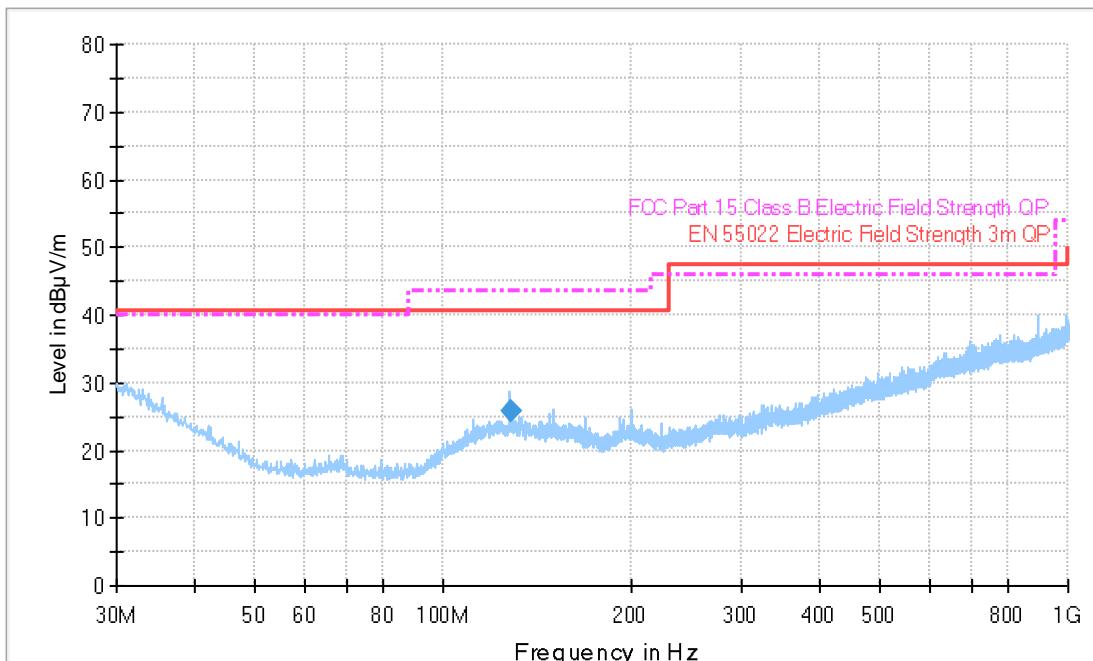
Measurement Data and Plot:

EUT Test Mode:

- Receive Mode

Frequency Range:

- 30MHz to 1GHz



Plot 21: Radiated Emissions scanned at 3m SAC

Table 30: QPeak Data of Radiated Emissions measured 3m SAC

Freq. (MHz)	QPeak (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Ant. Ht. (cm)	Pol	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dB μ V/m)
128.000000	25.9	1000.000	120.000	344.0	V	187.0	20.6	17.6	43.5

3.10 Frequency Stability

Date Performed:

March 16, 2017

Test Standard:

- FCC Title 47 CFR Part 15: Subpart C §15.215
- RSS-Gen Issue 4: Clause 8.8

Test Method:

- ANSI C63.4-2014

Test Requirement:

FCC (15.215(c)): The 20dB bandwidth must remain within the designated frequency band over the expected variations in temperature and voltage range.

RSS-Gen Issue 4 (8.8): Transmitter frequency stability for licence-exempt radio apparatus shall be measured in accordance with Section 6.11. For licence-exempt radio apparatus, the frequency stability shall be measured at temperatures of -20°C (-4°F), +20°C (+68°F) and +50°C (+122°F) instead of at the temperatures specified in Section 6.11. If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable standard (RSS), measurement of the frequency stability is not required provided that the occupied bandwidth of the licence-exempt radio apparatus lies entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-806MHz.

Result:

The EUT complies with the applicable standard.

Measurement Data and Plot:

Table 31: Frequency Stability Data

Channel	Temperature (°C)	Frequency (GHz)	Deviation (ppm)
Low Channel 2402MHz	-30	2.40199328	-2.80
	-20	2.4020036	1.50
	-10	2.4020086	3.58
	0	2.4020087	3.62
	10	2.4020052	2.16
	20	2.4019999	-0.04
	30	2.4019934	-2.75
	40	2.4019872	-5.33
	50	2.4019825	-7.29
Mid Channel 2440MHz	-30	2.4399931	-2.83
	-20	2.4400036	1.48
	-10	2.4400087	3.57
	0	2.4400088	3.61
	10	2.4400052	2.13
	20	2.4399998	-0.08
	30	2.4399933	-2.75
	40	2.439987	-5.33
	50	2.4399821	-7.34
High Channel 2480MHz	-30	2.4799929	-2.86
	-20	2.4800037	1.49
	-10	2.4800088	3.55
	0	2.4800088	3.55
	10	2.4800054	2.18
	20	2.4799999	-0.04
	30	2.4799931	-2.78
	40	2.4799868	-5.32
	50	2.4799818	-7.34

3.11 RF Exposure Evaluation

Date Performed:

April 17, 2017

Test Standard:

- FCC CFR 47 §1.1310
- RSS-102 Section 2.5.2

Test Requirement:

FCC CFR 47 §1.1310:

"Radiofrequency radiation exposure limits for General Population/Uncontrolled Exposure at Frequency range 1500 - 100000 MHz: 1.0 mW/cm^2"

RSS-102 Section 2.5.2:

"RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

-at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived."

RF Exposure Evaluation Bluetooth Low Energy (BLE):

All operating modes assume an antenna to person distance of >20cm.

Maximum peak conducted output power measured for BLE was 2.97dBm when the EUT was operated at 2402MHz.

Frequency (MHz)	Peak Output power (dBm)	Antenna Max Gain (dBi)	EIRP (dBm)	EIRP (mW)
2402	2.47	0.5	2.97	1.98

$$\text{Power Density} = \frac{\text{EIRP}}{4\pi r^2} \text{ mW/cm}^2$$

As per above equation power density at 20cm = $\frac{1.98}{4\pi(3.14)(20)^2} = 3.94 \times 10^{-4}$ mW/cm² which is far below the limit 1.0 mW/cm² as per FCC 47 CFR §2.1091 & §1.1310

As per **RSS-102 Section 2.5.2** *"RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:*

- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz

As per above equation source-based, time-averaged maximum e.i.r.p. of the device is equal to or less 2.67W.

EIRP of this EUT is 1.98mW which is far below the exemption limit 2.67W as per RSS-102 Section 2.5.2.

Appendix A: TEST SETUP PICTURES



Figure 1: Radiated Emissions (frequency range: 10kHz ↔ 30MHz) Test Setup

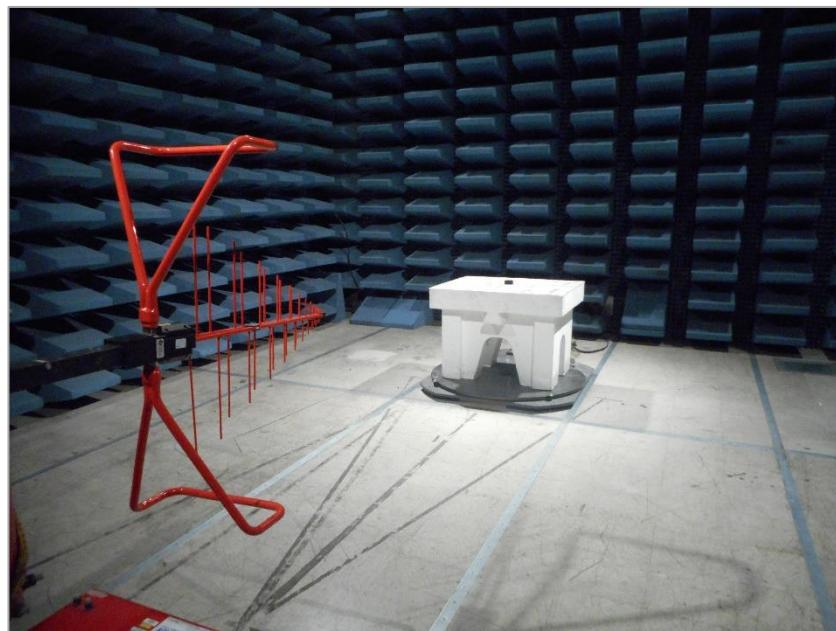


Figure 2: Radiated Emissions (frequency range: 30MHz ↔ 1GHz) Test Setup



Figure 3: Radiated Emissions (close-up view) Test Setup

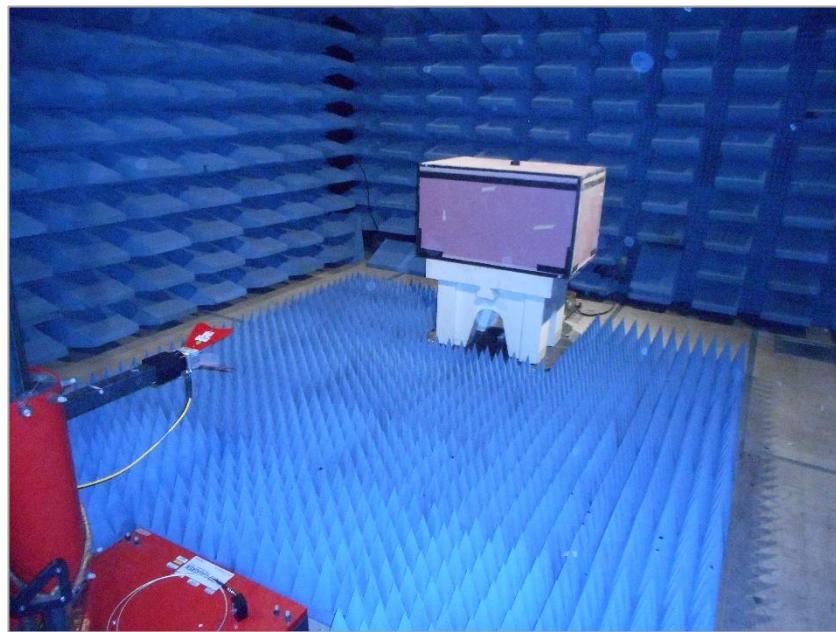


Figure 4: Radiated Emissions (frequency range: 1GHz ↔ 18GHz) Test Setup



Figure 5: Radiated Emissions (frequency range: 18GHz ↔ 26.5GHz) Test Setup

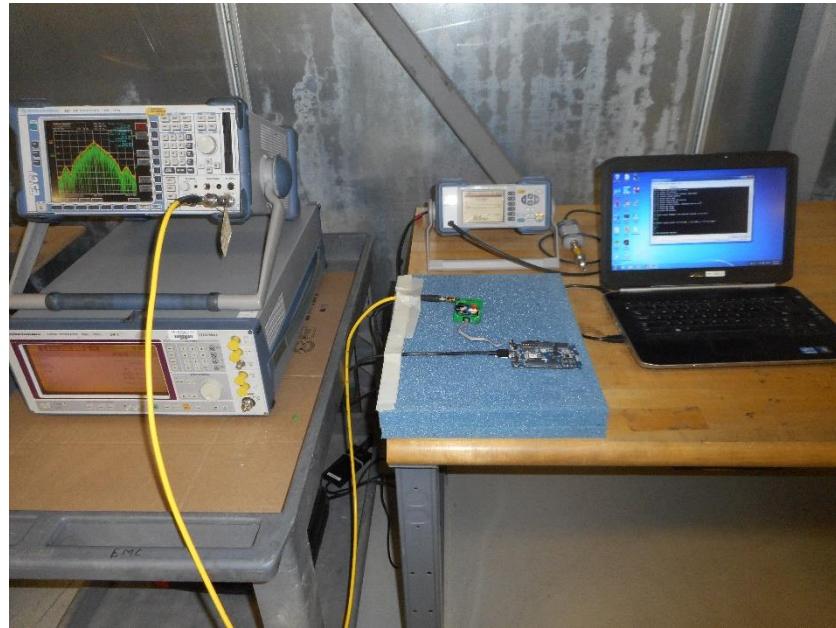


Figure 6: RF Output Power and Occupied Bandwidth Conducted Measurements Test Setup

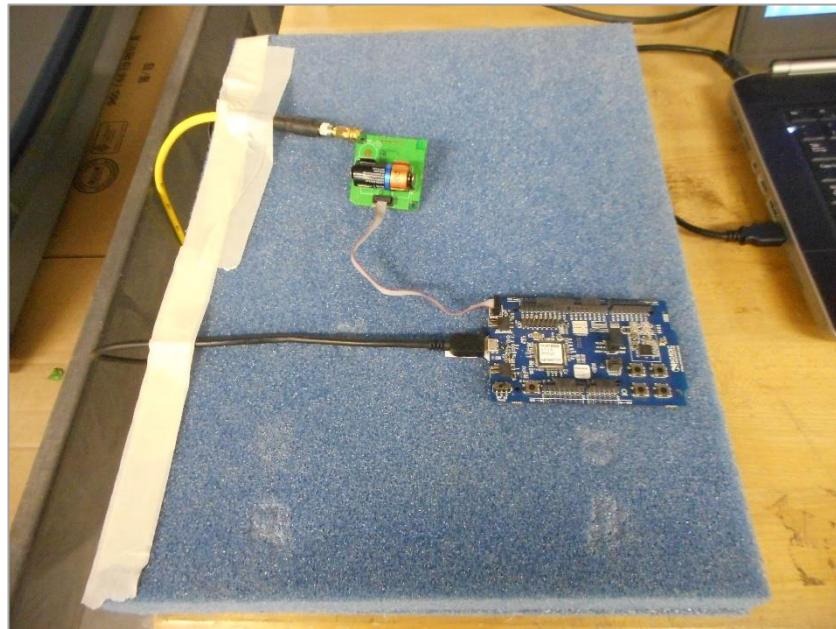


Figure 7: RF Output Power and Occupied Bandwidth Conducted Measurements (close-up views) Test Setup

Appendix B: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
DC	Direct Current
E.I.R.P.	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
EUT	Equipment Under Test
FCC	Federal Communications Commission
IC	Industry Canada
ICES	Interference-Causing Equipment Standard
LISN	Line Impedance Stabilizing Network
OATS	Open Area Test Site
RF	Radio Frequency
RMS	Root-Mean-Square
RSS	Radio Standards Specifications
SAC	Semi-Anechoic Chamber

END OF REPORT