COMPLIANCE WORLDWIDE INC.
TEST REPORT 213-19

In Accordance with the Requirements of

FCC PART 15.247, SUBPART C
Innovation, Science and Economic Development Canada
RSS-247, Issue 2

Low Power License-Exempt Radio Communication Devices
Intentional Radiators

Issued to

IsoLynx, LLC.
179 Ward Hill Avenue
Haverhill, MA 01835
978-556-9780

for the

IsoLynx II UWB Tracking Tag
Model: IL0401

FCC ID: 2AHCQ-IL0401

Report Issued on May 21, 2019

Tested by

Brian F. Breault

Reviewed by

Larry K. Stillings

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1. Scope

This test report certifies that the IsoLynx Flex Tag, as tested, meets the FCC Part 15, Subpart C and ISED Canada RSS-247, Issue 2 requirements. The scope of this test report is limited to the test sample provided by the client, only in as much as that sample represents other production units. If any significant changes are made to the unit, the changes shall be evaluated and a retest may be required.

2. Product Details

2.1. Manufacturer:	IsoLynx, LLC
2.2. Model Number:	IL0401
2.3. Serial Number:	02050435
2.4. Description:	The IsoLynx Flex Tag is a small, battery-powered RFID device that produces ultrawideband pulses that are used to generate real-time location and movement data.
2.5. Power Source:	DC 3.7 Volts
2.6. Hardware Revision:	2.1.1
2.7. Software Version:	N/A
2.8. Modulation Type:	GFSK
2.9. Operating Frequency:	2.4 GHz to 2.4835 Nominal
2.10. EMC Modifications:	None

3. Product Configuration

3.1. Operational Characteristics & Software

Hardware Setup:

The tag was pre-configured with firmware that allowed it to transmit on the low, middle and high BLE channels by giving the unit a hard shake. Operation is confirmed by the number of blinks of the red led. One blink, channel 37, two blinks, channel 38, three blinks, channel 39, four blinks, receive only.

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3. Product Configuration (continued)

3.1. Operational Characteristics & Software (continued)

During all radiated emissions measurement testing, the product was mounted on a polystyrene form to facilitate rotating the device through three orthogonal axes, as required by ANSI C63.10, section 5.10.1, for a hand held or body worn device. The three axes were defined as follows:

X Axis	Charge contacts on the rear lower left.	Unit is vertical. Interface contacts face antenna at 0º.
Y Axis	Charge contacts on the rear lower right.	Unit is vertical. Interface contacts face antenna at 0º.
Z Axis	Interface contacts face up.	Charge and interface contacts closest to antenna at 0º.

X-Axis

Y-Axis

Z-Axis

3.2. EUT Hardware

Manufacturer	Model/Part # / Options	Serial Number	Input Voltage	Freq (Hz)	Description/Function
IsoLynx	IL0401	02050337	3.7	DC	UWB / BLE Tag

3.3. EUT Cables/Transducers

Cable Type	Length	Shield	From	To
USB	2M	Yes	EUT	USB Charger

3.4. Support Equipment

Manufacturer	Model/Part # / Options	Serial Number	Input Voltage	Freq (Hz)	Description/Function
Anker	71AN10W	---	100-240	50-60	5VDC, 2A charger for conducted emissions and charging the device and conducted emissions.

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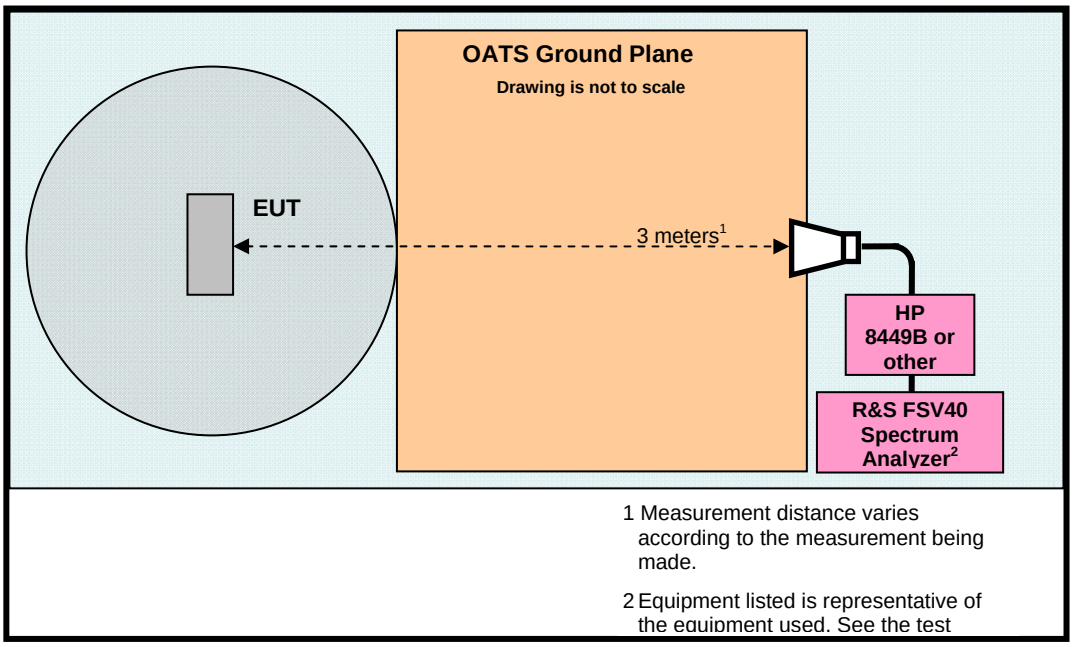
3. Product Configuration

3.5. Block Diagram



4. Measurements Parameters

4.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due	Interval
EMI Test Receiver, 9kHz - 7GHz [1]	Rohde & Schwarz	ESR7	101156	9/10/2020	2 Years
EMI Test Receiver, 10 Hz - 7GHz [1]	Rohde & Schwarz	ESR7	101770	10/3/2020	2 Years
Spectrum Analyzer, 2 Hz to 26.5 GHz[2]	Rohde & Schwarz	FSW26	102057	9/13/2020	2 Years
Spectrum Analyzer, 9 kHz to 40 GHz[3]	Rohde & Schwarz	FSV40	100899	9/10/2020	2 Years
EMI Receiver 9 kHz - 1 GHz	Hewlett Packard	8546A	3650A00360	9/11/2020	2 Years
Loop Antenna 9 kHz - 30 MHz	EMCO	6512	9309-1139	1/28/2022	3 Years
Biconilog Antenna, 30 MHz - 2 GHz	Sunol Sciences	JB1	A050913	6/3/2021	2 Years
Horn Antenna, 960 MHz to 18 GHz	Electro-Metrics	EM-6961	6337	10/3/2020	2 Years
Horn Antenna, 18 GHz to 40 GHz	Com-Power	AH-840	101032	9/28/2020	2 Years
Preamplifier, 1 GHz to 26.5 GHz	Hewlett Packard	8449B	3008A01323	9/11/2020	2 Years
Preamplifier 18 to 40 GHz	Miteq	JSD42-21004200-40-5P	649199/649219	10/31/2019	1 Year
Digital Barometer	Control Company	4195	ID236	4/3/2020	2 Years
Temperature Chamber	Associated Environmental	SD-308	10782	CNR	

[1] ESR7 Firmware revision: V3.46 SP1, Date installed: 12/22/2018 Previous V3.36 SP2, installed 12/5/2018.
[2] FSW26 Firmware revision: V4.30 SP1, Date installed: 02/22/2019 Previous V3.36 SP2, installed 10/26/2018.
[3] FSV40 Firmware revision: V2.30 SP4, Date installed: 05/04/2016 Previous V2.30 SP1, installed 10/22/2014.

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4. Measurements Parameters (continued)

4.2. Measurement Software

Manufacturer	Software Description	Title or Model #	Rev.	Report Sections
Compliance Worldwide	Test Report Generation Software	Test Report Generator	1.0	7.9. Conducted Emissions

4.3. Measurement & Equipment Setup

Test Dates:	5/3/2019 to 5/20/2019
Test Engineer:	Brian Breault
Normal Site Temperature (15 - 35°C):	19.0
Relative Humidity (20 -75%RH):	31
Frequency Range:	30 kHz to 40 GHz
Measurement Distance:	3, 1.5, 1 and 0.3 Meters
EMI Receiver IF Bandwidth:	200 Hz - 10 kHz to 150 kHz 9 kHz - 150 kHz to 30 MHz 120 kHz - 30 MHz to 1 GHz 1 MHz - Above 1 GHz
EMI Receiver Average Bandwidth:	1 kHz - 10 kHz to 150 kHz 30 kHz - 150 kHz to 30 MHz 300 kHz - 30 MHz to 1 GHz 3 MHz - Above 1 GHz
Detector Function:	Peak, QP - 10 kHz to 1 GHz Peak, Avg - Above 1 GHz Unless otherwise specified.

4.4. Measurement Procedures

Test measurements were made in accordance FCC Part 15.247: Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5850 MHz, and 24.0 - 24.25 GHz.

The measurement procedures in this report are in accordance with ANSI C63.10-2013: *American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices*. FCC OET Publication Number KDB 558074 D01 v05r02, *Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247*, dated April 2, 2019, was also referenced for the test procedures used to generate the data in this report. All references to FCC OET publication number 558074 refer to this version of the publication.

All radiated emissions measurements include correction factors for antenna, cables, preamp and attenuators, if used.

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4. Measurements Parameters

4.5. Measurement Uncertainty

The following uncertainties are expressed for an expansion/coverage factor of K=2.

RF Frequency	$\pm$ 1x10^{-8}
Radiated Emission of Transmitter	$\pm$ 4.55 dB
Radiated Emission of Receiver	$\pm$ 4.55 dB
Temperature	$\pm$ 0.91^{o} C
Humidity	$\pm$ 5%

5. Choice of Equipment for Test Suits

5.1 Choice of Model

This test report is based on the one test sample supplied by the manufacturer. These units are reported by the manufacturer to be equivalent to the production units.

5.2 Presentation

The test samples were tested complete with all required ancillary equipment. Refer to Section 3 of this report for product equipment configuration.

5.3 Choice of Operating Frequencies

The IsoLynx Flex Tag, as tested, operates on 40 channels, from channels 0 to 39 in the 2.4 GHz band.

In accordance with ANSI C63.10-2013, section 5.6, and FCC Part 15.31 (m), the choice of operating frequencies selected for the testing detailed in this report are as follows:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	9	2422	18	2442	28	2462
0	2404	10	2424	19	2444	29	2464
1	2406	38	2426	20	2446	30	2466
2	2408	11	2428	21	2448	31	2468
3	2410	12	2430	22	2450	32	2470
4	2412	13	2432	23	2452	33	2472
5	2414	14	2434	24	2454	34	2474
6	2416	15	2436	25	2456	35	2476
7	2418	16	2438	26	2458	36	2478
8	2420	17	2440	27	2460	39	2480

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5. Choice of Equipment for Test Suits (continued)

5.4 Mode of Operation

Modulation type : GFSK
Payload pattern : PRB29
Payload Length : 37 bytes

For band edge measurements (section 7.6), the DTS bandwidth measurements were taken into consideration for the worst case examples.

6. Measurement Summary

Test Requirement	FCC Rule Requirement	ISED Rule Requirement	Test Report Section	Result
Antenna Requirement	15.203	---	7.1	Compliant
Minimum DTS Bandwidth	15.247 (a) (2)	RSS-247 5.2 a)	7.2	Compliant
Maximum Peak Conducted Output Power	15.247 (b) (1)	RSS-247 5.4 d)	7.3	Compliant
Operation with directional antenna gains greater than 6 dBi	15.247 (b) (4)	---	7.4	Compliant
Spurious Radiated Emissions	15.247 (d)	RSS-GEN 6.13	7.5	Compliant
Spurious Radiated Emissions (> GHz) - Harmonic Measurements	15.247 (d)	RSS-GEN 6.13		Compliant
Lower and Upper Band Edges	15.247 (d)	RSS-GEN 6.13	7.6	Compliant
Emissions in Non-restricted Frequency Bands	15.247(e)	RSS-GEN 6.13	7.7	Compliant
Peak Power Spectral Density	15.247(e)	RSS-247 5.2 b)	7.8	Compliant
AC Power Line Conducted Emissions	15.207	RSS-GEN 7.2	7.9	Compliant
Duty Cycle	15.207	N/A	7.10	Compliant
99% (Occupied) Bandwidth	1.1307 (b) (1)	RSS-GEN 6.7	7.11	Compliant
Public Exposure to Radio Frequency Energy Levels	1.1307 (b) (1)	RSS-GEN, Issue 5, Section 3.4, RSS 102	7.12	Compliant

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7. Measurement Data

7.1. Antenna Requirement (15.203)

Requirement: 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.

Results: The IsoLynx Flex Tag utilizes a chip antenna which is not user replaceable.

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7. Measurement Data

7.2. Minimum DTS Bandwidth (15.247 (a) (2, ISED RSS-247 5.2 a))

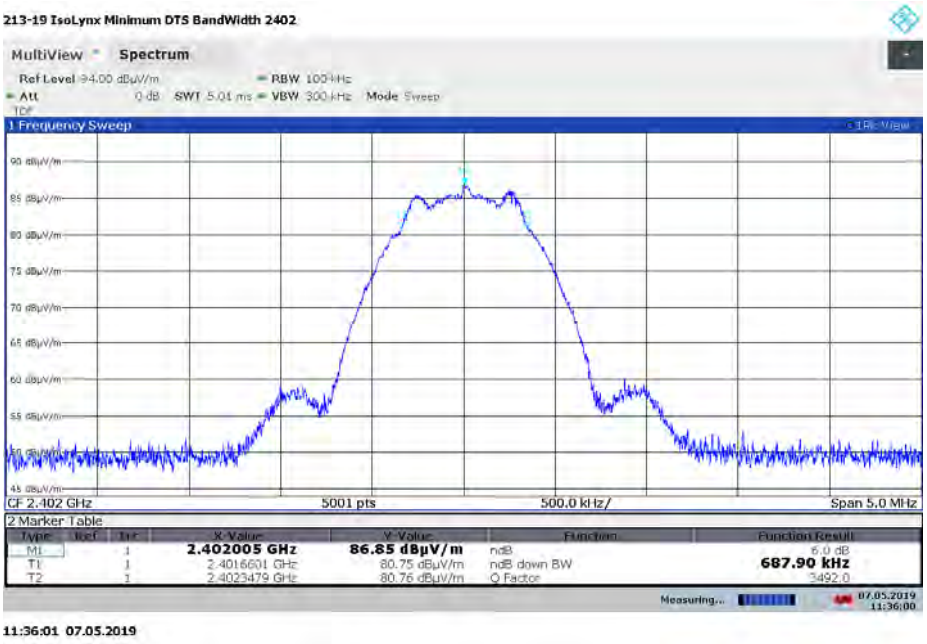
Requirement: (15.247 (a) (2)
Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Procedure: This test was performed in accordance with the procedure detailed in FCC OET publication number 558074, Section 8.1 Option 1, DTS (6 dB) Channel Bandwidth.

Results: The device under test meets the minimum 500 kHz DTS (6 dB) bandwidth requirement.

Channel	Frequency (MHz)	-6 dB Bandwidth (kHz)	Minimum -6 dB Bandwidth (kHz)	Result
37	2402	687.90	>500	Compliant
38	2426	706.90	>500	Compliant
39	2480	695.90	>500	Compliant

7.2.1. Low Channel – 37, 2402 MHz



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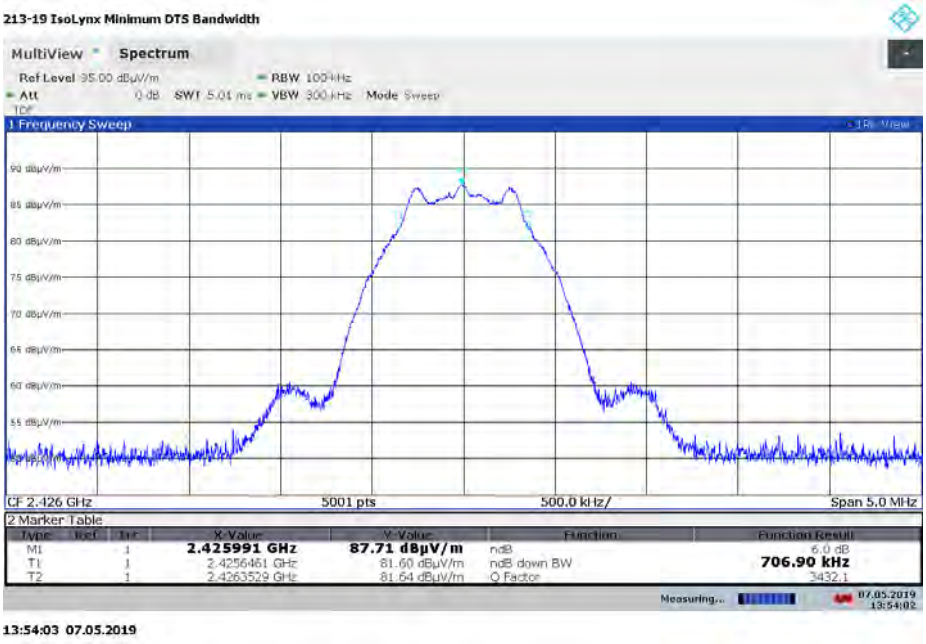
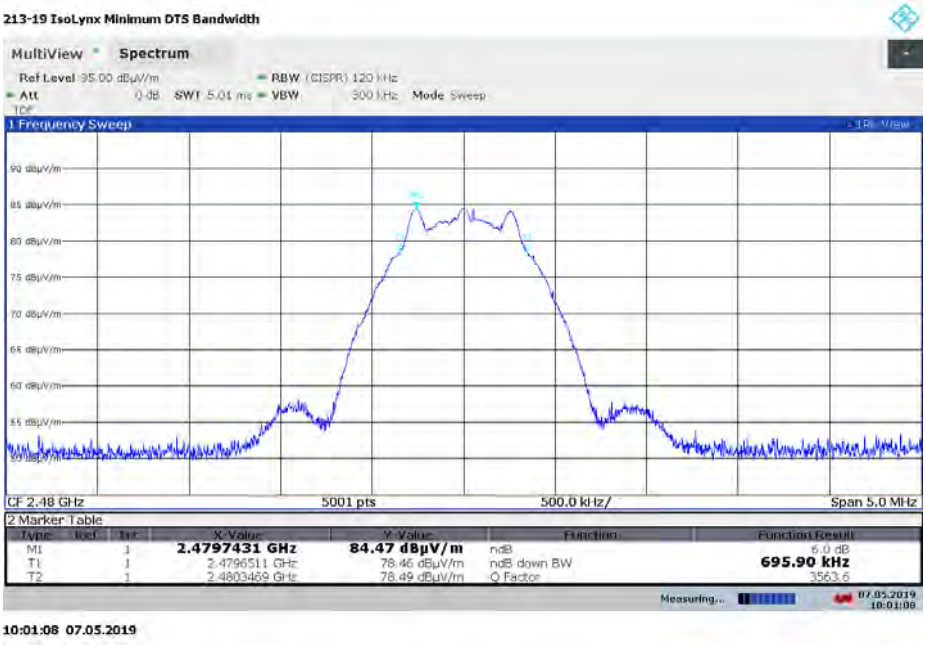
7. Measurement Data

7.2. Minimum DTS Bandwidth (15.247 (a) (2)) (continued)

7.2.2. Middle Channel – 38, 2426 MHz



7.2.3. High Channel – 39, 2480 MHz



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7. Measurement Data (continued)

7.3. Maximum Peak Conducted Output Power (FCC 15.247 (b)(3), ISED RSS-247 5.4 d)

Requirement: (15.247 (b) (3))
The maximum peak conducted output power of the intentional radiator shall not exceed the following: For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt (+30 dBm).

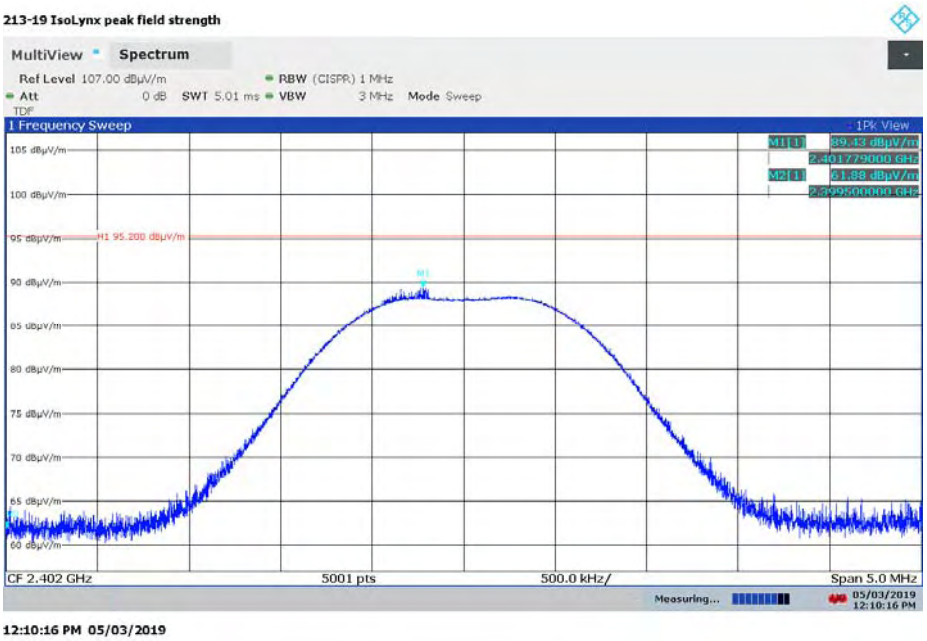
Procedure: This test was performed in accordance with the procedure detailed in FCC OET publication number KDB 558074, Section 9.1.1.

Test Note: A spectrum analyzer resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz were used to meet the requirements of FCC OET publication number 558074, Section 9.1.1 and the measured product DTS bandwidth.

Results: The device under test meets the required maximum peak conducted output power level of 1 Watt (125.2 dBµV/m at 3 Meters).

Channel	Frequency	Maximum Peak Radiated Output Power	Peak Limit	Margin	Result
	(MHz)	(dBµV/m)	(dBµV/m)	(dB)	
37	2402	89.43	125.2	-35.77	Compliant
38	2426	90.14	125.2	-35.06	Compliant
39	2480	91.38	125.2	-33.82	Compliant

7.3.1. Low Channel – 37, 2402 MHz



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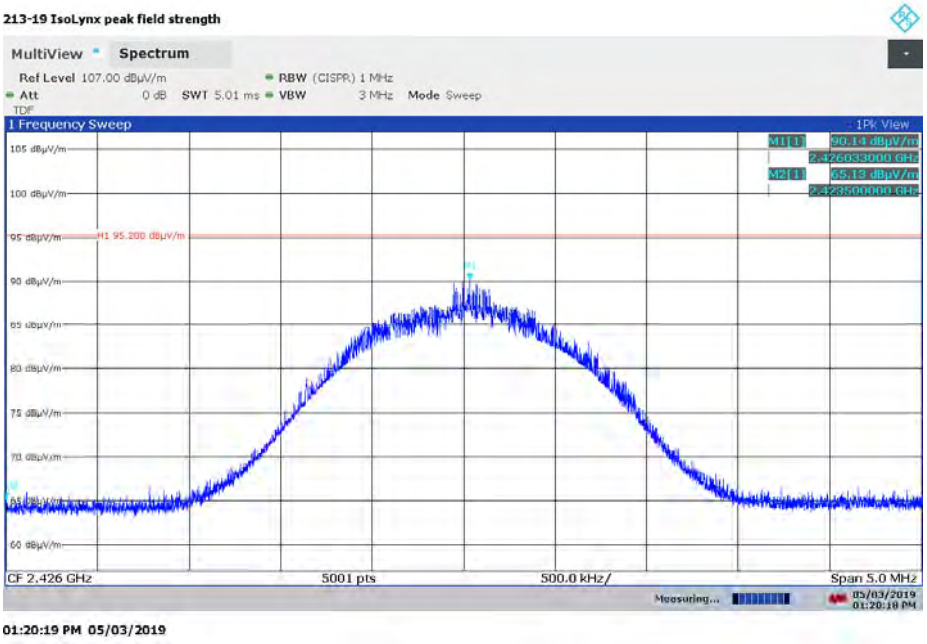
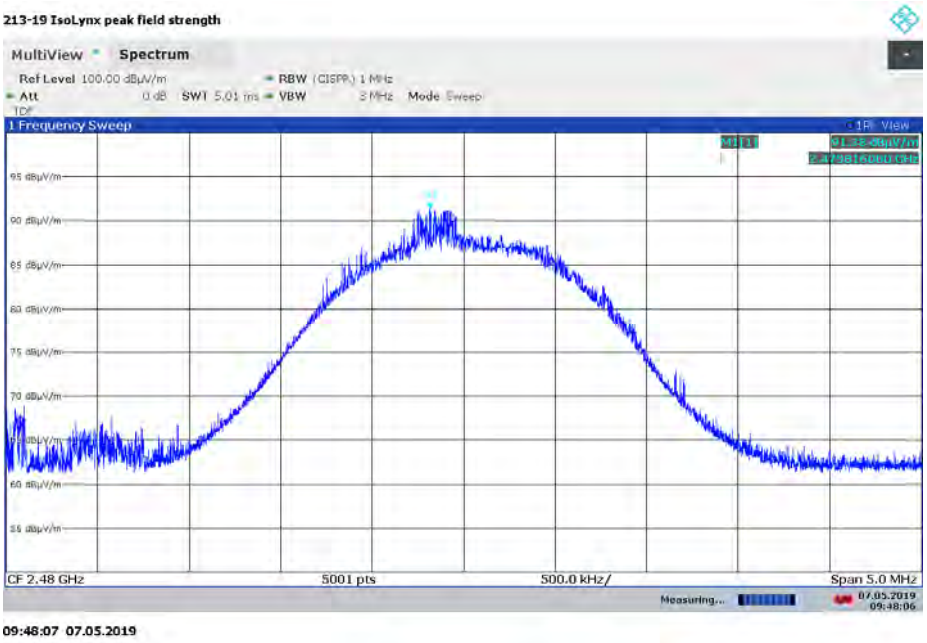
7. Measurement Data

7.3. Maximum Peak Conducted Output Power (continued)

7.3.2. Middle Channel – 38, 2426 MHz



7.3.3. High Channel – 39, 2480 MHz



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7. Measurement Data

7.4. Operation with directional antenna gains greater than 6 dBi (15.247 (b)(4))

Requirement: If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of FCC Part 15.247, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Procedure: Not applicable for the device under test.

DUT Status: The DUT utilizes an antenna with a 0.9 dBi gain and therefore is exempt from this requirement.

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7. Measurement Data (continued)

7.5. Transmitter Spurious Radiated Emissions (30 kHz to 40 GHz) (FCC 15.209, ISED RSS-GEN 6.13)

7.5.1 Transmitter Spurious Radiated Emissions

Requirement: (15.209) The Emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency Range (MHz)	Distance (Meters)	Limit (dBµV/m)[1]
0.009 to 0.490	3	128.5 to 93.8
0.490 to 1.705	3	73.8 to 63.0
1.705 to 30	3	69.5
30 to 88	3	40.0
88 to 216	3	43.5
216 to 960	3	46.0
>960	3	54.0

[1] Measurements in the 9 to 90 kHz, 110 to 490 kHz and above 1000 MHz ranges employ an average detector. Otherwise a quasi-peak detector is used.

Procedure: This test was performed in accordance with the procedure detailed in FCC OET publication number 558074, Section 12.0: Emissions in restricted frequency bands and FCC 47CFRPart 15.209: Radiated Emission Limits; General Requirements.

The test methods used to generate the data in this test report is in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

Test Notes: Measurements were made from the lowest oscillator frequency as stated by the manufacturer (32.768 kHz) to the 10th harmonic of the highest transmitter frequency or 40 GHz, whichever is lower.

Reference FCC Part 15.33(a) and FCC Part 15.33(a)(1).

Each of the test modes documented within the test report were evaluated and the worst case of each of the test modes is detailed in this section. A full set of measurement scans are presented in Appendix A of this test report.

Results: The Emissions from the DUT did not exceed the field strength levels specified in the above table.

Frequency Range	Worst-Case Measured Frequency	Field Strength	FCC Part 15.209 Limit	Margin	Reference	Receive Antenna Polarity
	(MHz)	(dBµV/m)	(dBµV/m)	(dB)	Appendix A	(H/V)
30 kHz - 150 kHz	0.03150	81.11	117.62	-36.51	A1.2.3	Gnd Parallel
150 kHz - 30 MHz	0.86775	35.80	68.85	-33.05	A2.3.6	Gnd Parallel
30 MHz - 1000 MHz	840.99000	31.33	46.00	-14.67	A3.3.5	H
1000 MHz - 10000 MHz	7207.470	49.56	74.00	-24.44	A4.1.1	H
10000 MHz - 18000 MHz	17884.190	47.39	74.00	-26.61	A5.1.6	V
18000 MHz - 40000 MHz	39544.700	48.85	74.00	-25.15	A6.3.1	H

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7. Measurement Data (continued)

7.5. Transmitter Spurious Radiated Emissions (30 kHz to 40 GHz) (FCC 15.209, ISED RSS-GEN 6.13)

7.5.2. Transmitter Spurious Radiated Emissions (Harmonic Meas.) Test Results

Worst case measurements of Harmonics that fall into the restricted bands.

7.5.2.1. 2.4 GHz, BLE

Freq. (MHz)	Field Strength (dBµV/m)[1]		Limit (dBµV/m)		Margin (dBµV/m)		Antenna Polarity (H/V)	Result
	Peak	Average	Peak	Average	Peak	Average		
4804	52.21	39.32	74.00	54.00	-21.79	-14.68	V	Compliant
4852	52.48	39.46	74.00	54.00	-21.52	-14.54	H	Compliant
4960	52.81	41.27	74.00	54.00	-21.19	-12.73	H	Compliant
7278	53.29	40.35	74.00	54.00	-20.71	-13.65	V	Compliant
7440	54.02	40.62	74.00	54.00	-19.98	-13.38	H	Compliant
12010	59.50	45.51	74.00	54.00	-14.50	-8.49	H	Compliant
12130	60.41	46.69	74.00	54.00	-13.59	-7.31	V	Compliant
12400	60.24	46.09	74.00	54.00	-13.76	-7.91	H	Compliant
19216	35.94	35.94	74.00	54.00	-38.06	-18.06	H	Compliant
19520	49.95	36.15	74.00	54.00	-24.05	-17.85	H	Compliant
19840	49.44	36.49	74.00	54.00	-24.56	-17.51	V	Compliant
22320	50.87	36.49	74.00	54.00	-23.13	-17.51	H	Compliant

[1] All correction factors are stored in the spectrum analyzer and applied to this column entry.

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7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements) (FCC 15.209, ISED RSS-GEN 6.13)

Requirement: 15.247(d) 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Procedure: For the lower band edge, this measurement was performed in accordance with the procedure detailed in FCC OET publication number 558074, Section 11: Emissions in non-restricted frequency bands.

For the upper band edge, this measurement was performed as a typical restricted band radiated emissions measurement above 1 GHz. Peak and CISPR average detectors and a 1 MHz resolution and 3 MHz video bandwidth were utilized.

Test Note: The radiated band edge and worst case out of band measurements in this report represent the measurements made with the worst case receive antenna polarity and product orthogonal position. In addition, the DTS bandwidth measurements were taken into consideration for the worst case examples.

Results: The DUT met the 20 dB requirement at the lower band edge and the Part 15.209 requirements at the upper band edge.

7.6.1. Lower Band Edge

Band Edge Frequency	Lowest Transmitter Frequency	Maximum PSD (100 kHz)	Band Edge Delta to Max PSD (100 kHz)	Minimum Required Delta	Result
(MHz)	(MHz)	(dBµV/m)	(dB)	(dB)	
2400	2402	83.81	-34.47	-20	Compliant

Note: Reference the plot on the following page.

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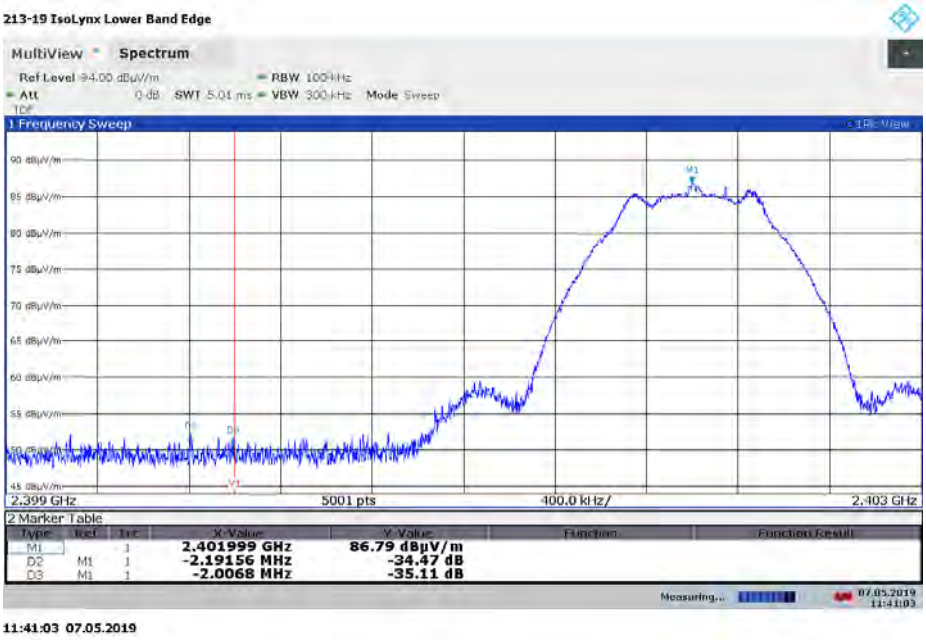
7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements (continued)

Lower Band Edge



7.6.2. Upper Band Edge and Worst Case Out of Band

Upper Band Edge

Band Edge Frequency	Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Result
(MHz)	Peak	Average	Peak	Average	Peak	Average	
2483.5	60.35	49.21	74	54	-13.65	-4.79	Compliant

Worst Case Out of Band

Band Edge Frequency	Out of Band Frequency	Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dBµV/m)		Result
(MHz)	(MHz)	Peak	Average	Peak	Average	Peak	Average	
2483.5	2488.0048	61.46	49.44	74	54	-12.54	-4.56	Compliant

Note: Reference the plot on the following page**.**

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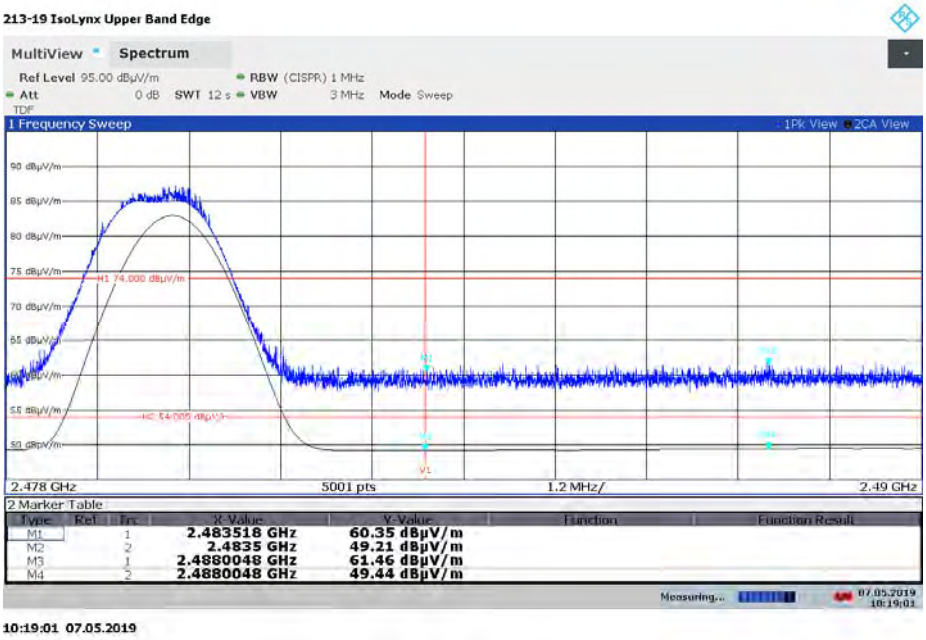
7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements (continued)

Upper Band Edge and Worst Case Out of Band



7.6.3. Lower Restricted Band, 2.310 MHz to 2390 MHz

Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Result
Peak	Average	Peak	Average	Peak	Average	
62.23	49.55	74	54	-11.77	-4.45	Compliant

Note: Reference the plot on the following page.

7.6.4. Upper Restricted Band, 2483.5 MHz, to 2500 MHz

Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Result
Peak	Average	Peak	Average	Peak	Average	
62.44	49.27	74	54	-11.56	-4.73	Compliant

Note: Reference the plot on the following page.

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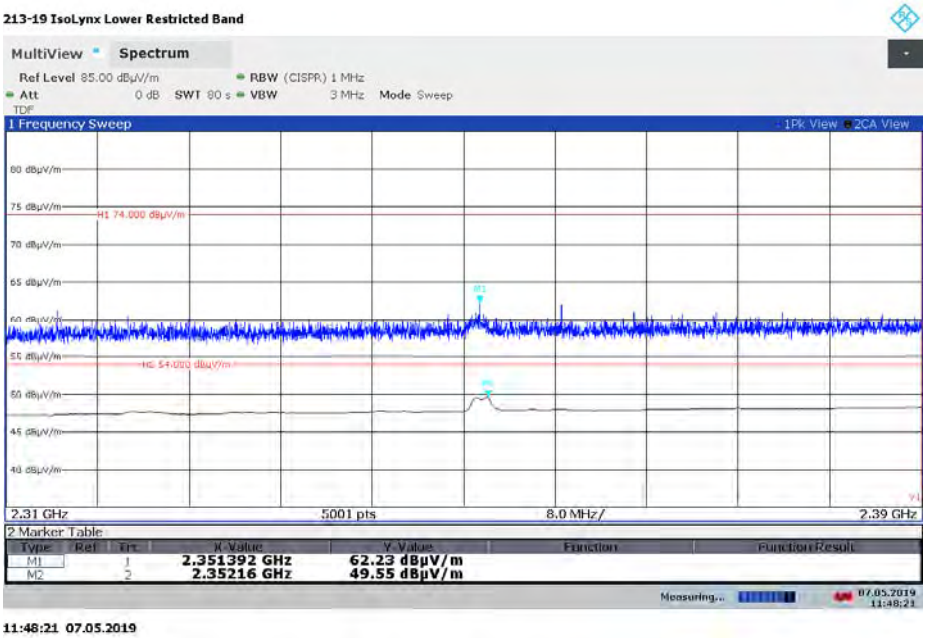
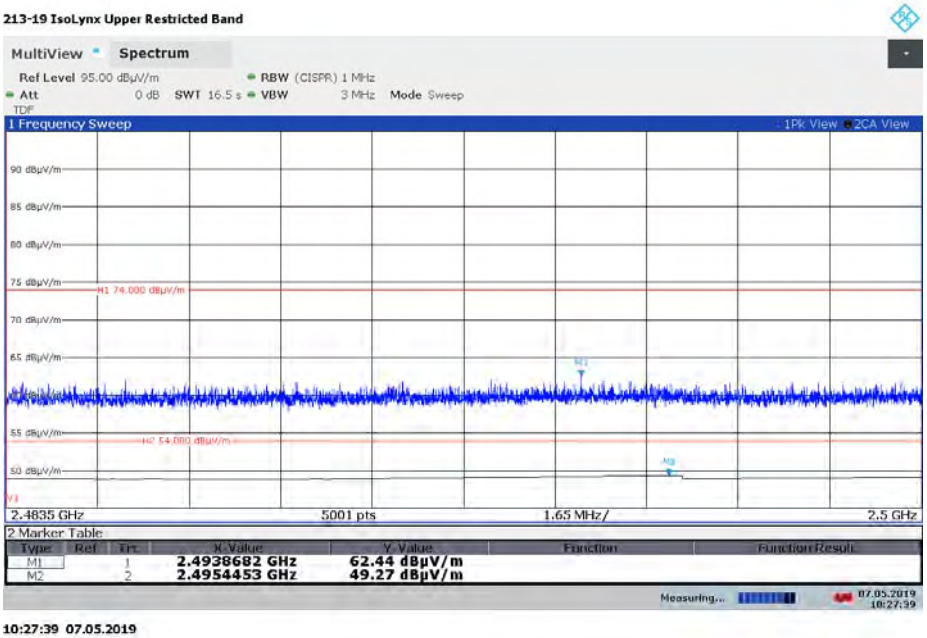
7. Measurement Data (continued)

7.6. Band Edge and Out of Band Measurements (continued)

Lower Restricted Band, 2310 MHz, to 2390 MHz



Upper Restricted Band, 2483.5 MHz, to 2500 MHz



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7. Measurement Data (continued)

7.7. Emissions in Non-restricted Frequency Bands

Requirement: 15.247(d) 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, provided the transmitter demonstrates compliance with the peak conducted power limits.

Test Notes: Peak in-band measurements were taken at the time the DTS (-6 dB) bandwidth measurements were made. These values were used as the reference levels for the following measurements. Refer to section 7.2 of this report for these values.

Results: The DUT met the 20 dB requirement emission level delta requirement in the non restricted frequency bands.

Emissions in Non-restricted Frequency Bands

Maximum PSD (100 kHz) In-Band[1] (dBµV/m)	Worst Case Out-of-Band Frequency[2] (MHz)	Maximum PSD (100 kHz) Out-of-Band (dBµV/m)	Delta to Maximum PSD (dB)	Minimum Required Delta	Result
86.79	2493.8682	62.44	-24.35	-20 dB	Compliant

[1]Taken from Section 7.6 - Lower Band Edge

[2]Taken from Section 7.6 - Upper Restricted Band

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7. Measurement Data (continued)

7.8. Peak Power Spectral Density (FCC 15.247(e), ISED RSS-247, 5.2 b))

Requirement: For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm (103.2 dBµV/m) in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of FCC Part 15.247. The same method of determining the conducted output power shall be used to determine the power spectral density.

Procedure: FCC OET publication number 558074, Section 10.2: Method PKPSD (peak PSD). FCC OET 662911 was referenced to determine the procedure for measuring in-band power spectral density of transmitters with multiple outputs in the same band.

Results: The DUT met the required power spectral density limit at the tested frequencies.

Measurement Results in 2400 MHz to 2483.5 MHz Band

Channel	Frequency	Maximum PSD Frequency	Maximum Power Spectral Density	Limit	Margin	Result
	(MHz)	(MHz)	(dBµV/m)	(dBµV/m)	(dB)	
37	2402	2402.0064	73.86	103.2	-29.34	Compliant
38	2426	2425.9787	75.35	103.2	-27.85	Compliant
39	2480	2480.1515	68.57	103.2	-34.63	Compliant

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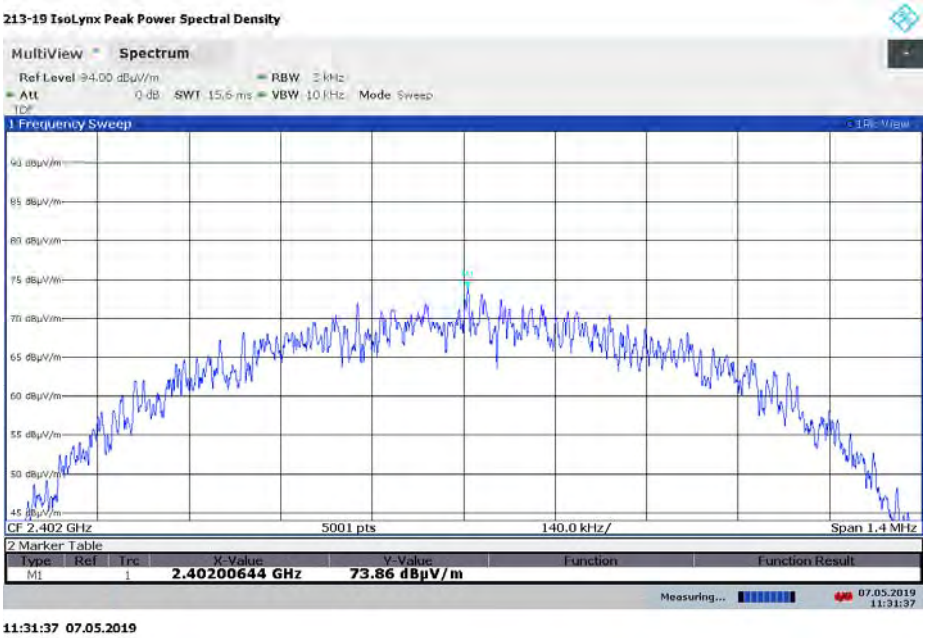
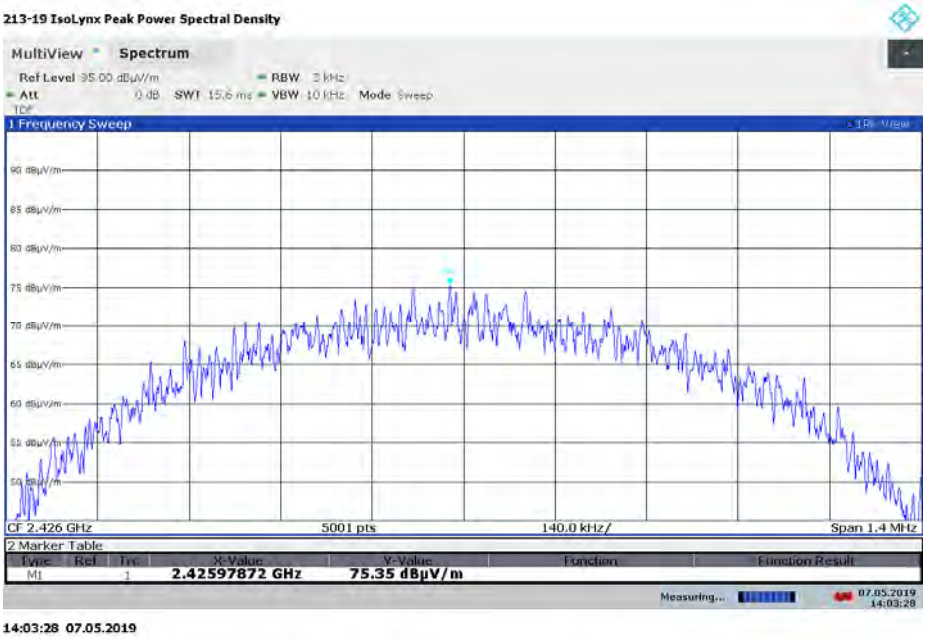
7. Measurement Data (continued)

7.8. Peak Power Spectral Density (15.247(e)), ISED RSS-247, 5.2 b)) (continued)

7.8.1. Low Channel – 37, 2402 MHz



7.8.2. Middle Channel – 38, 2426 MHz



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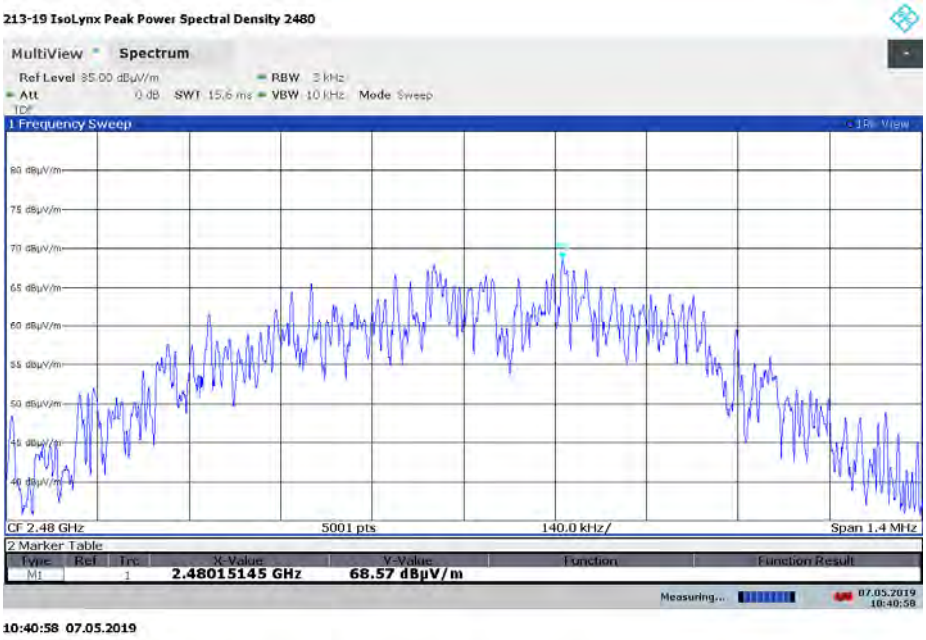
7. Measurement Data

7.8. Peak Power Spectral Density (15.247(e)), ISED RSS-247, 5.2 b)) (continued)

7.8.3. High Channel – 39, 2480 MHz



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7. Measurement Data (continued)

7.9. Conducted Emissions (FCC 15.207, ISED RSS-GEN 7.2)

Requirement: 15.207 With certain exceptions, an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-Peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5.0	56	46
5.0 to 30.0	60	50
* Decreases with the logarithm of the frequency.		

Procedure: This test was performed in accordance with the procedure detailed in ANSI C63.10-2013, Section 6.2: Standard test method for ac power-line conducted emissions from unlicensed wireless devices.

Test Notes: The device was tested using the support equipment laptop.

Results: The device under test meets the FCC Part 15.207 test requirements.

Measurement & Equipment Setup

Test Date:	5/9/2019
Test Engineer:	Brian Breault
Site Temperature (°C):	22.8
Relative Humidity (%RH):	48.3
Frequency Range:	0.15 MHz to 30 MHz
EMI Receiver IF Bandwidth:	9 kHz
EMI Receiver Avg Bandwidth:	30 kHz
Detector Functions:	Peak, Quasi-Peak & Average

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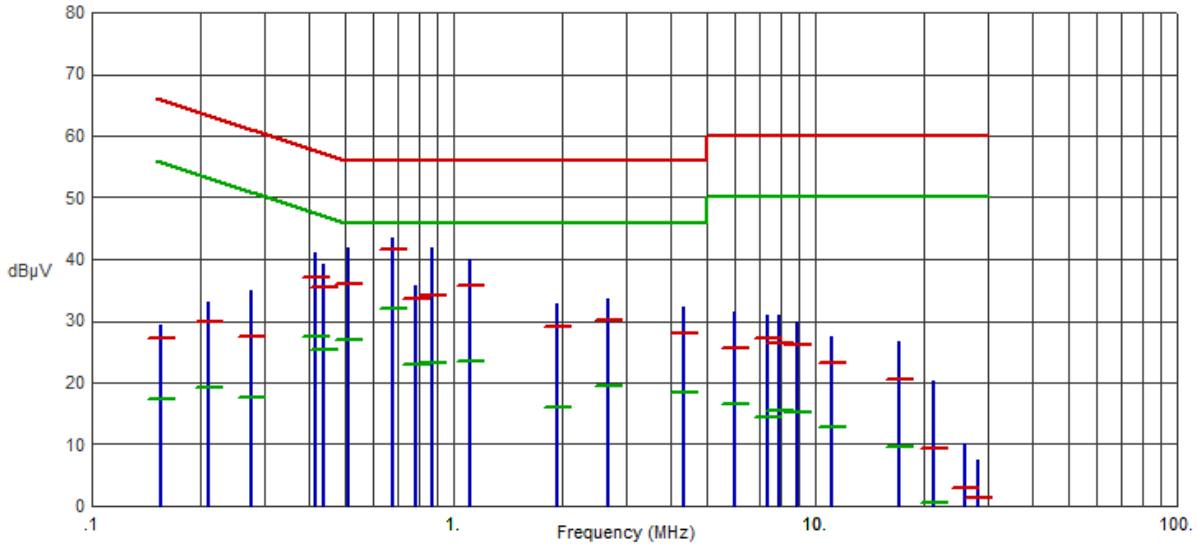
7. Measurement Data (continued)

7.9. Conducted Emissions (FCC 15.207, ISED RSS-GEN 7.2) (continued)

7.9.1. 120 Volts, 60 Hz Phase

Test No.: 213-19, 120 Volts, 60 Hz Phase FCC Part 15.207



Frequency (MHz)	Pk Amp (dBµV)	QP Amp (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Avg Amp (dBµV)	Avg Limit (dBµV)	Avg Margin (dB)	Comments
.1556	29.38	27.21	65.70	-38.49	17.28	55.70	-38.42	
.2111	33.03	29.85	63.16	-33.31	19.10	53.16	-34.06	
.2760	34.87	27.39	60.94	-33.55	17.61	50.94	-33.33	
.4144	41.14	37.05	57.56	-20.51	27.42	47.56	-20.14	
.4392	39.16	35.56	57.08	-21.52	25.40	47.08	-21.68	
.5118	41.79	36.01	56.00	-19.99	26.86	46.00	-19.14	
.6820	43.36	41.63	56.00	-14.37	32.01	46.00	-13.99	
.7873	35.86	33.55	56.00	-22.45	22.90	46.00	-23.10	
.8740	41.97	34.20	56.00	-21.80	23.29	46.00	-22.71	
1.1120	39.95	35.83	56.00	-20.17	23.44	46.00	-22.56	
1.9300	32.90	28.99	56.00	-27.01	16.05	46.00	-29.95	
2.6819	33.47	30.22	56.00	-25.78	19.53	46.00	-26.47	
4.3203	32.22	27.97	56.00	-28.03	18.43	46.00	-27.57	
5.9892	31.39	25.63	60.00	-34.37	16.41	50.00	-33.59	
7.3938	30.91	27.27	60.00	-32.73	14.43	50.00	-35.57	
7.9484	30.94	26.47	60.00	-33.53	15.47	50.00	-34.53	
8.8892	29.93	26.01	60.00	-33.99	15.14	50.00	-34.86	
11.1185	27.48	23.10	60.00	-36.90	12.69	50.00	-37.31	
17.1192	26.80	20.44	60.00	-39.56	9.52	50.00	-40.48	
21.3408	20.31	9.37	60.00	-50.63	0.43	50.00	-49.57	
25.8723	10.10	2.81	60.00	-57.19	-4.25	50.00	-54.25	
28.2539	7.39	1.24	60.00	-58.76	-5.55	50.00	-55.55	

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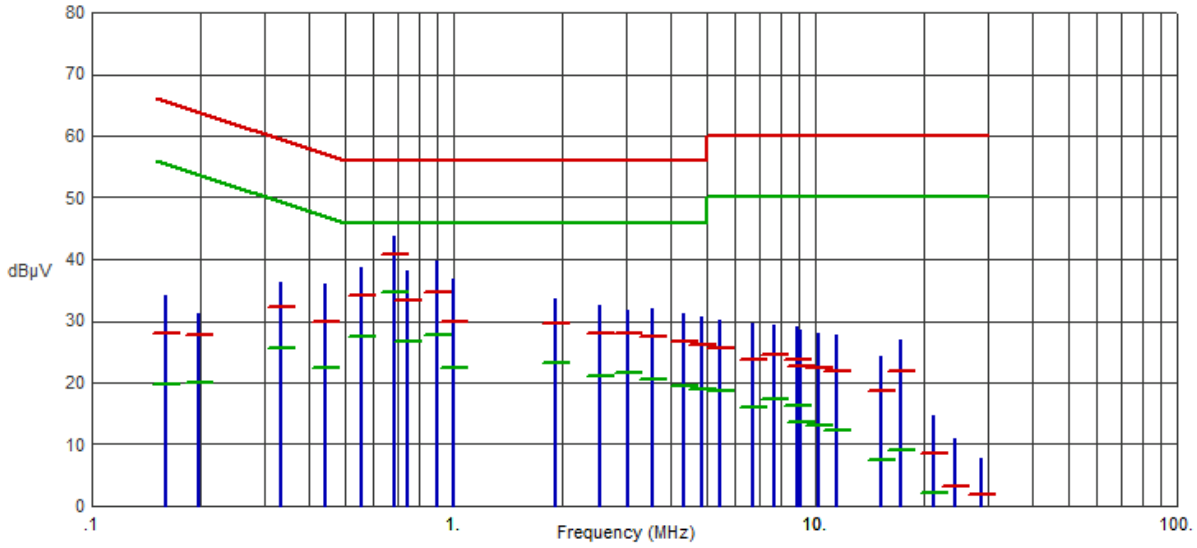
7. Measurement Data (continued)

7.9. Conducted Emissions (FCC 15.207, ISED RSS-GEN 7.2) (continued)

7.9.2. 120 Volts, 60 Hz Neutral

Test No.: 213-19, 120 Volts, 60 Hz Neutral FCC Part 15.207



Frequency (MHz)	Pk Amp (dBµV)	QP Amp (dBµV)	QP Limit (dBµV)	QP Margin (dB)	Avg Amp (dBµV)	Avg Limit (dBµV)	Avg Margin (dB)	Comments
.1602	34.24	27.88	65.45	-37.57	19.77	55.45	-35.68	
.1981	31.14	27.60	63.69	-36.09	19.93	53.69	-33.76	
.3344	36.17	32.23	59.34	-27.11	25.67	49.34	-23.67	
.4410	35.99	29.74	57.04	-27.30	22.42	47.04	-24.62	
.5557	38.59	34.07	56.00	-21.93	27.47	46.00	-18.53	
.6835	43.68	40.71	56.00	-15.29	34.74	46.00	-11.26	
.7487	38.06	33.32	56.00	-22.68	26.71	46.00	-19.29	
.8961	39.67	34.66	56.00	-21.34	27.74	46.00	-18.26	
1.0021	36.79	29.91	56.00	-26.09	22.35	46.00	-23.65	
1.9193	33.50	29.57	56.00	-26.43	23.15	46.00	-22.85	
2.5319	32.60	27.88	56.00	-28.12	21.00	46.00	-25.00	
3.0441	31.62	28.09	56.00	-27.91	21.54	46.00	-24.46	
3.5551	31.96	27.38	56.00	-28.62	20.66	46.00	-25.34	
4.3152	31.12	26.55	56.00	-29.45	19.46	46.00	-26.54	
4.8481	30.63	26.05	56.00	-29.95	19.05	46.00	-26.95	
5.4728	30.16	25.66	60.00	-34.34	18.54	50.00	-31.46	
6.7094	29.63	23.83	60.00	-36.17	16.04	50.00	-33.96	
7.7358	29.41	24.53	60.00	-35.47	17.43	50.00	-32.57	
8.9351	28.94	23.85	60.00	-36.15	16.23	50.00	-33.77	
9.1076	28.43	22.74	60.00	-37.26	13.69	50.00	-36.31	
10.2536	27.96	22.27	60.00	-37.73	13.19	50.00	-36.81	
11.4296	27.64	21.89	60.00	-38.11	12.32	50.00	-37.68	
15.1605	24.21	18.70	60.00	-41.30	7.46	50.00	-42.54	
17.2081	27.02	21.87	60.00	-38.13	8.94	50.00	-41.06	
21.1710	14.62	8.59	60.00	-51.41	2.16	50.00	-47.84	
24.2480	10.92	3.17	60.00	-56.83	-4.48	50.00	-54.48	
28.7498	7.65	1.81	60.00	-58.19	-4.72	50.00	-54.72	

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7. Measurement Data (continued)

7.10. Duty Cycle

Requirement: (FCC OET publication number 558074)
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%).

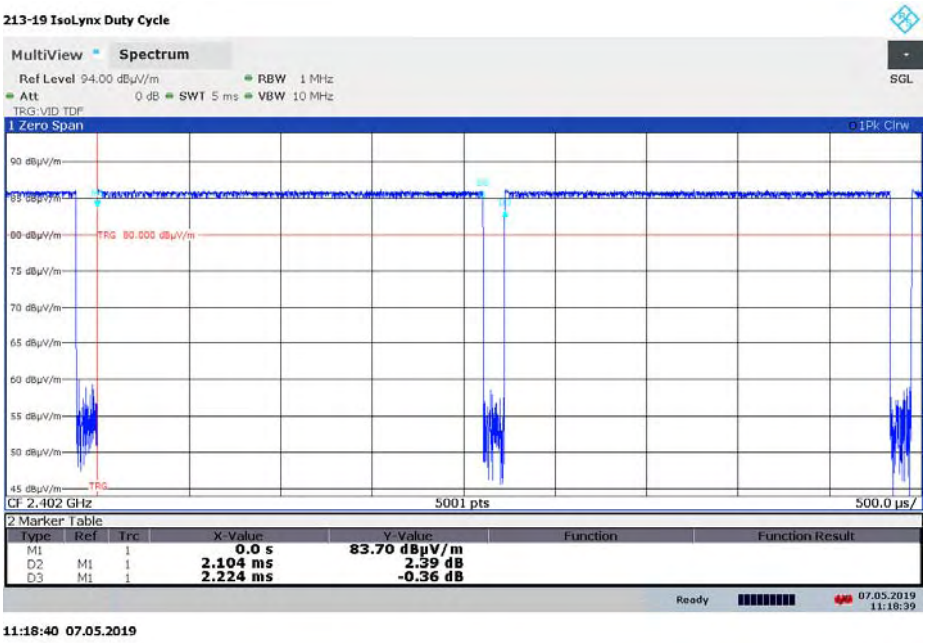
Procedure: Duty cycle measurements were made according to the procedure detailed ANSI C63.10-2013, Section 11.6(b)

Results: Duty cycle measurements are listed in the following table.

All power and power spectral density measurements for this report are peak mode measurements. Ample peak hold time was provided to ensure maximum peak measurements.

Channel	Frequency	Time High	Time per Period	Duty Cycle	
	(MHz)	(µS)	(µS)	(Numeric)	(%)
37	2402	2.104	2.224	0.94604	89.58
38	2426	2.104	2.224	0.94604	89.58
39	2480	2.104	2.224	0.94604	89.58

7.10.1. Low Channel – 37, 2402 MHz



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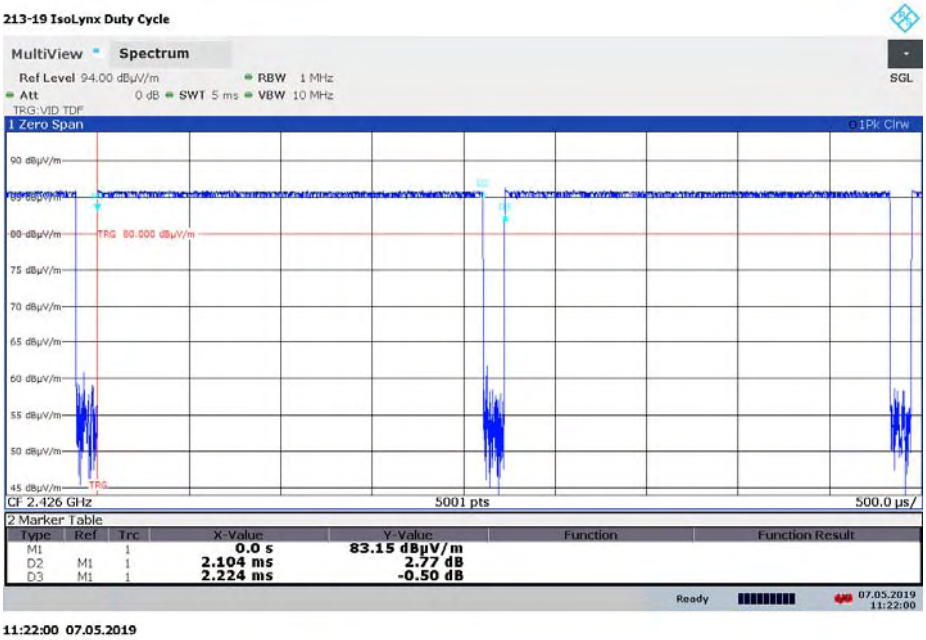
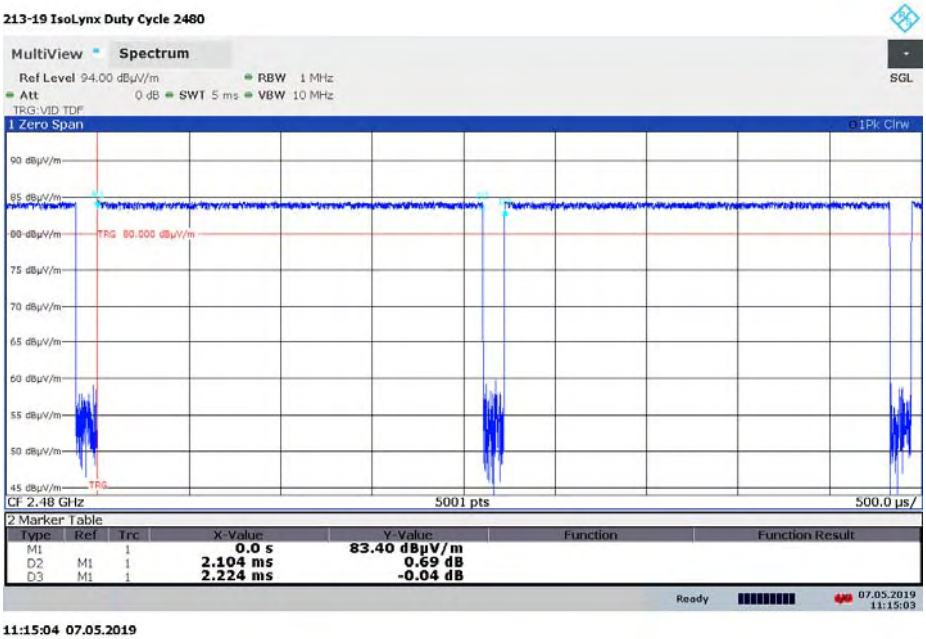
7. Measurement Data (continued)

7.10. Duty Cycle (continued)

7.10.2. Middle Channel – 38, 2426 MHz



7.10.3. High Channel – 39, 2480 MHz



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6. Measurement Data (continued)

7.11. 99% (Occupied) Bandwidth (RSS-GEN 6.7)

Requirement: The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

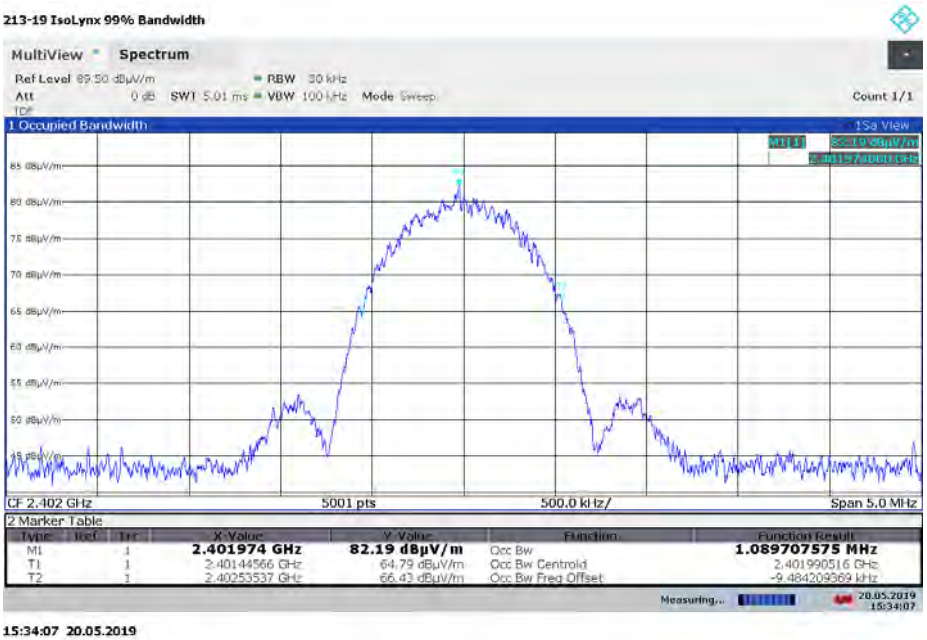
The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.

The sample detector of the spectrum analyzer shall be used to make the measurement.

7.11.1. Measurement Results

Channel	Channel Frequency (MHz)	99% Power Bandwidth (MHz)
Low	2402	1.0897
Middle	2626	1.0817
High	2480	1.0845

7.11.1.1. 99% Power Bandwidth – Low Frequency (2402 MHz)



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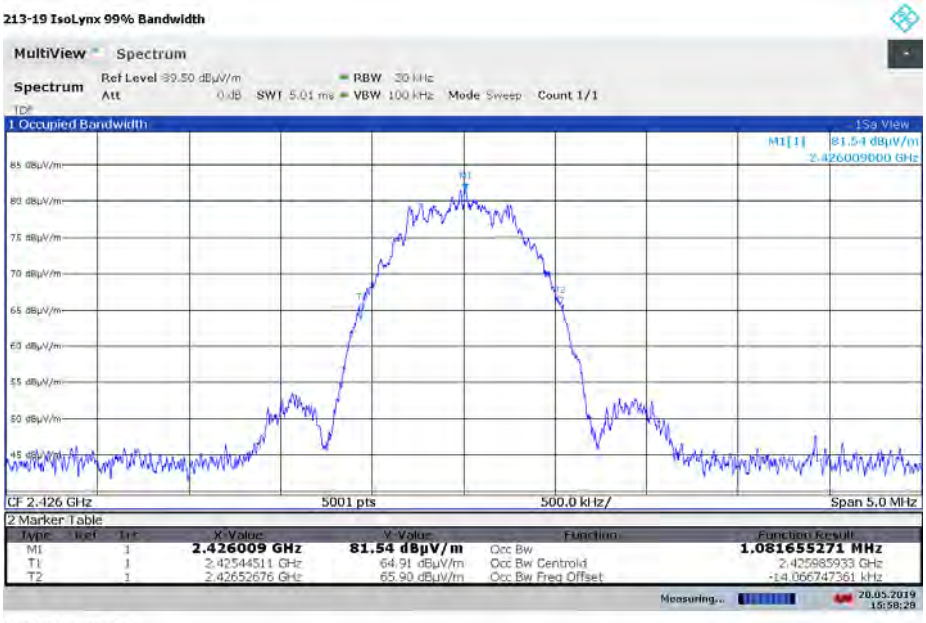
6. Measurement Data (continued)

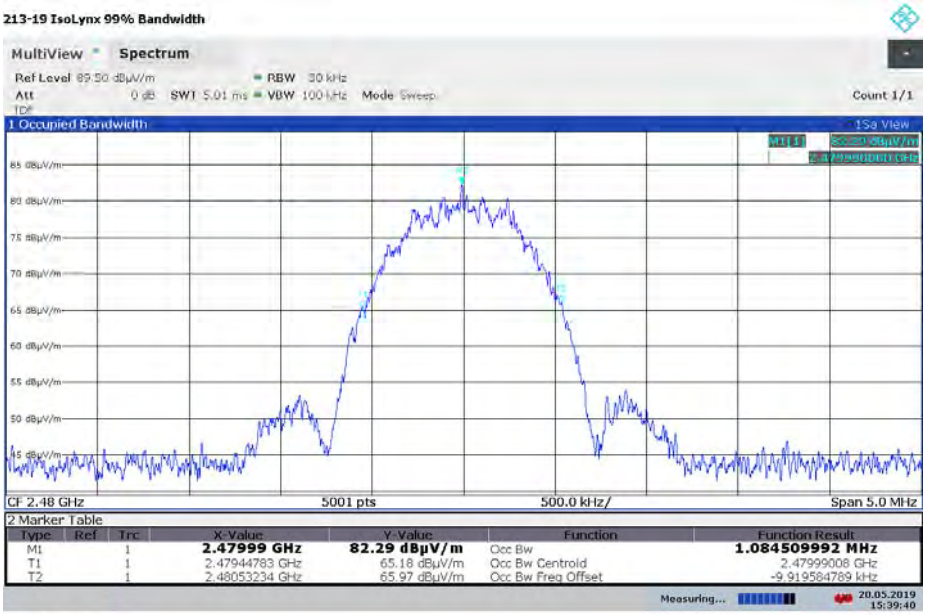
6.8. 99% Bandwidth (RSS-GEN 6.7)

7.11.1.2. 99% Power Bandwidth – Middle Frequency (2441 MHz)



15:58:28 20.05.2019

7.11.1.3. 99% Power Bandwidth – High Frequency (2480 MHz)



15:39:40 20.05.2019

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7. Measurement Data (continued)

7.11. Public Exposure to Radio Frequency Energy Levels (15.247(i) (1.1307 (b)(1)) RSS-GEN, ISSUE 4 5.5, RSS-102)

7.11.1. 15.247(i) (1.1307 (b)(1) Requirements

Requirement: Portable devices are subject to radio frequency radiation exposure requirements.

For a 1-g head or body SAR, the test exclusion result must be ≤ 3.0.
For a 10-g extremity SAR, the test exclusion result must be ≤ 7.5.

Test Notes: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{SAR Test Exclusion} = \frac{P_{MAX}}{d_{MIN}} \times \sqrt{f_{(GHz)}} \quad (1)$$

P_{MAX}	mW	Maximum power of channel, including tune-up tolerance
d_{MIN}	mm	Minimum test separation distance, mm (≤ 50 mm)
$f_{(GHz)}$	GHz	$f_{(GHz)}$ is the RF channel transmit frequency in GHz (>100 MHz and <6 GHz)

(1) FCC OET 447498 - Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

Results: Passed - The device under test meets the exclusion requirement detailed in FCC OET 447498.

Channel:		**37**	**38**	**39**	
Input[1]:	P_{MAX}	0.265	0.312	0.415	**mW**
	d_{MIN}[2]	5.00	5.00	5.00	**mm**
	$f_{(GHz)}$	2.402	2.626	2.480	**GHz**
Test Exclusion:		**0.08**	**0.10**	**0.13**	
Limit Exemption:		**3.0**	**3.0**	**3.0**	
Measurement Result:		**Compliant**	**Compliant**	**Compliant**	

[1] Taken from column 3 of the table in Section 7.3 of this test report.

[2] When the minimum test separation distance is < 5 mm, a distance of 5 mm according to KDB 447498, 4.1 f) is applied to determine SAR test exclusion.

Note: BLE and UWB Radios do not transmit simultaneously.

7.11.2. IC RSS-102 Issue 5 SAR Evaluation (Reference RSS-102, Table 1)

Frequency	Separation Distance	Maximum Power	RSS-102 Limit	Result
MHz	mm	mW	mW	
2402	≤5	0.26	10.65	Compliant
2626	≤5	0.31	7.60	Compliant
2480	≤5	0.41	9.86	Compliant

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8. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with the Federal Communications Commission (FCC) and Industry Canada standards. Through our American Association for Laboratory Accreditation (A2LA) ISO Guide 17025 Accreditation our test sites are designated with the FCC (designation number **US1091**), Industry Canada (file number **IC 3023A-1)** and VCCI (Member number 3168) under registration number A-0274.

Compliance Worldwide is also designated as a Phase 1 CAB under APEC-MRA (US0132) for Australia/New Zealand AS/NZS CISPR 22, Chinese-Taipei (Taiwan) BSMI CNS 13438 and Korea (RRA) KN 11, KN 13, KN 14-1, KN 22, KN 32, KN 61000-6-3, KN 61000-6-4.

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane. A second conducted emissions site is also located in the basement of the OATS site with a 2.3 x 2.5 meter ground plane and a 2.4 x 2.4 meter vertical wall.

Both sites are designed to test products or systems 1.5 meters W x 1.5 meters L x 2.0 meters H, floor standing or table top.

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9. Test Setup Photographs

9.1. Spurious Radiated Emissions, 10 kHz to 1 GHz – Front

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9. Test Setup Photographs

9.2. Spurious Radiated Emissions, 10 kHz to 30 MHz – Rear

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9. Test Setup Photographs

9.3. Spurious Radiated Emissions, 30 MHz to 1 GHz – Rear

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9. Test Setup Photographs

9.4. Radiated Emissions Above 1 GHz – Front

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9. Test Setup Photographs

9.5. Radiated Emissions 1 to 18 GHz – Rear

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9. Test Setup Photographs

9.6. Radiated Emissions Above 18 GHz – Rear

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9. Test Setup Photographs

9.7. Power Line Conducted Emissions – Front

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9. Test Setup Photographs

9.8. Power Line Conducted Emissions – Rear

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