



RADIO TEST REPORT

For

MODEL NO. 1756

FCC ID: C3K1756

IC ID: 3048A-1756

Test Report No. R-TR378-FCCIC-BTLE-5

Issue Date: 14 Oct, 2016

FCC CFR47 Part 15 Subpart C
Innovation Science and Economic Development
Canada RSS-247 Issue 1

Prepared by

Microsoft EMC Laboratory
17760 NE 67th Ct,
Redmond WA, 98052, U.S.A.
425-421-9799

sajose@microsoft.com



1 Record of Revisions

Revision	Date	Section	Page(s)	Summary of Changes	Author/Revised By:
1.0	08/05/2016	All	All	Version 1.0	Daniel Salinas
2.0	08/19/2016	9.5.4	22	Corrected typo for test margins.	Daniel Salinas
3.0	09/27/2016	4 9.3 9.6.4	5 17-18 24	-Updated MU Table. -Added 99% BW data. -Corrected typo for emission amplitude.	Daniel Salinas
4.0	10/13/2016	10.1.2 10.1.5.1	30 32	- Add reference to KDB 937606. - Removed irrelevant data.	Daniel Salinas
5.0	10/14/2016	10.1.5.1	32	- Updated comments.	Daniel Salinas

Table of Contents

1	Record of Revisions.....	2
2	Deviations from Standards	5
3	Facilities and Accreditations	5
3.1	Test Facility	5
3.2	Accreditations.....	5
3.3	Test Equipment	5
4	Measurement Uncertainty.....	5
5	Product Description	6
5.1	Test Configurations.....	6
5.2	Environmental Conditions	6
5.3	Antenna Requirements	6
5.4	Equipment Modifications	7
5.5	Dates of Testing	7
6	Test Results Summary	8
7	Test Equipment List.....	9
8	Test Site Description.....	10
8.1	Radiated Emissions Test Site	10
8.2	Antenna port conducted measurements.....	10
8.3	Test Setup Diagrams	11
9	Test Results- Conducted	14
9.1	Duty Cycle	14
9.2	6-dB Bandwidth.....	15
9.3	Occupied Bandwidth	17
9.4	Output Power	19
9.5	Peak Power Density.....	22
9.6	Conducted Spurious Emissions	24
9.7	Conducted Band Edge Emissions.....	28
10	Test Results- Radiated	30
10.1	Radiated Spurious and Band Edge Emissions	30
11	AC Line Conducted Emissions	41

Test Report Attestation

Microsoft Corporation**Model:** 1756**FCC ID:** C3K1756**IC ID:** 3048A-1756**Applicable Standards**

Specification	Test Result
FCC CFR47 Rule Parts 15.207, 15.209, 15.247	Pass
Innovation Science and Economic Development Canada RSS-247 Issue 1, RSS-Gen Issue 4	Pass

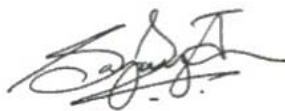
Microsoft EMC Laboratory attests that the product model identified in this report has been tested to and meets the requirements identified in the above standards. The test results in this report solely pertains to the specific sample tested, under the conditions and operating modes as provided by the customer.

This report shall not be used to claim product certification, approval, or endorsement by A2LA or any agency of any Government. Reproduction, duplication or publication of extracts from this test report is prohibited and requires prior written approval of Microsoft EMC Laboratory.

This report replaces the previously issued report #R-TR378-FCCIC-BTLE-4 issued by Microsoft EMC Labs on Oct 13, 2016.



Written by: Daniel Salinas
Radio Test Lead



Reviewed/ Approved by: Sajay Jose
EMC/RF Compliance Lab Manager

2 Deviations from Standards

None.

3 Facilities and Accreditations

3.1 Test Facility

All test facilities used to collect the test data are located at Microsoft EMC Laboratory,
 17760 NE 67th Ct,
 Redmond WA, 98052, USA

3.2 Accreditations

The lab is established and follows procedures as outlined in IEC/ISO 17025 and A2LA accreditation requirements.

A2LA Accredited Testing Certificate Number: 3472.01

FCC Registration Number: US1141

IC Site Registration Numbers: 3048A-3, 3048A-4

3.3 Test Equipment

The site and related equipment are constructed in conformance with the requirements of ANSI C63.4: 2014, CISPR 16-1-1 and other equivalent applicable standards. Test site requirements for measurements above 1 GHz are in accordance with ANSI C63.4 2014.

The calibrations of the measuring instruments, including any accessories that may affect such calibration, are checked frequently to assure their accuracy.

4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the product, calculated in accordance with ETSI TR 100 028-1, ETSI TS 103 051 and ETSI TS 103 052. This represents an expanded uncertainty expressed at 95% confidence level using a coverage factor $k=2$.

Expanded uncertainty calculations are available upon request.

Test item	Uncertainty	Unit
Radiated disturbance (9kHz to 30 MHz)	6.39	dB
Radiated disturbance (30 MHz to 1 GHz)	5.99	dB
Radiated disturbance (1 GHz to 18 GHz)	5.12	dB
Uncertainty for Conducted Power test	1.277	dB
Uncertainty for Conducted Spurious emission test	2.756	dB
Uncertainty for Bandwidth test	4.98	kHz
Uncertainty for DC power test	0.05	%
Uncertainty for test site temperature	0.5	°C
Uncertainty for test site Humidity	3	%
Uncertainty for time	0.189	%

5 Product Description

Company Name:	Microsoft Corporation
Address:	One Microsoft Way
City, State, Zip:	Redmond, WA 98052-6399
Customer Contact:	Chaitrali Limaye
Functional Description of the EUT:	Wireless input accessory device with BTLE Radio
Model:	1756
FCC ID:	C3K1756
IC ID:	3048A-1756
Radio Description:	BT LE (2400- 2483.5 MHz)
Modulation:	GFSK (Gaussian Frequency Shift Key)
Antenna Info:	Internal Antenna; Maximum manufacturer stated Antenna Gain: +1.73 dBi
EUT Classification:	DTS
Equipment Design State:	Production Equivalent
Equipment Condition:	Good
Test Sample Details:	Radiated: S/N: 0743511628574 Conducted: S/N: 0743743628574

5.1 Test Configurations

The EUT was preprogrammed to transmit continuously with a constant duty cycle on low, middle, and high channels.

Channel 0: Slow White LED blink.
 Channel 19: Fast white LED blink.
 Channel 39: Solid white LED blink.

5.2 Environmental Conditions

Ambient air temperature of the test site was within the range of 10 °C to 40 °C (50 °F to 104 °F) unless the EUT specified testing over a different temperature range. Humidity levels were in the range of 10% to 90% relative humidity. Testing conditions were within tolerance and any deviations required from the EUT are reported.

5.3 Antenna Requirements

The antenna is permanently attached. The EUT also has a conducted port out of the radio board specifically for conducted measurements. External antennas are not to be attached to this port.

5.4 Equipment Modifications

No modifications were made during testing.

5.5 Dates of Testing

Testing was performed July 20, 2016- July 29, 2016 and Sep 26, 2016.

6 Test Results Summary

Test Description	FCC CFR 47/ ISED C Rule Part	Limit	Test Result
6dB Bandwidth	15.247 (a)(2) RSS-247 [5.2]	> 500kHz	Pass
99% Occupied Bandwidth	Reporting purposes only.	Reporting purposes only.	N/A
Output Power	15.247 (b)(3) RSS-247 [5.4]	< 1 Watt	Pass
Power Spectral Density	15.247 (e) RSS-247 [5.2]	< 8dBm/3kHz	Pass
Conducted Band Edge/Spurious Emissions	15.247 (d) RSS-247 [5.5]	At least 20dBc	Pass
Radiated Spurious Emissions/ Restricted Band Emissions	15.205, 15.209 RSS-247 [5.5], RSS-Gen [8.9]	FCC CFR 47 15.209 limits RSS-Gen [8.9]	Pass
AC Power line Conducted Emissions	15.207 RSS-Gen [8.8]	FCC CFR 47 15.207 limits RSS-Gen [8.8]	N/A ⁽¹⁾

Note 1: The EUT is battery powered only, and cannot be connected directly or indirectly to AC mains.

7 Test Equipment List

Equipment used for Radiated and Conducted Measurements				
Manufacturer	Description	Model #	Asset #	Cal/Ver Due
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-192	4/13/2017
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-012	4/14/2017
Keysight	Spectrum Analyzer	N9030A	EMC-607	5/26/2017
ETS-Lindgren	Antenna – Passive Loop	6512	RF-202	1/08/2017
Sunol Sciences	Antenna - Broadband Hybrid	JB6	RF-201	1/11/2017
ETS-Lindgren	Antenna - Horn	3117	EMC-858	4/21/2017
ETS-Lindgren	Antenna -Horn	3117	RF-137	02/25/2017
ETS-Lindgren	Antenna - Standard Gain Horn	3160	RF-037	02/16/17
Rohde & Schwarz	Custom Filter Bank+PreAmp	SFUNIT RX	RF-323	12/10/2016
Rohde & Schwarz	Custom Filter Bank	SFUNIT RX	RF-324	12/18/2016
Rohde & Schwarz	Pre-Amp	TS-PR26	RF-199	12/10/2016
Rohde & Schwarz	Switch and Control Unit	OSP130	RF-249	12/10/2016
Rohde & Schwarz	Switch and Control Unit	OSP150	RF-250	12/10/2016
Rohde & Schwarz	Switch and Control Unit	OSP130	RF-018	12/18/2016
Rohde & Schwarz	Switch and Control Unit	OSP150	RF-019	12/18/2016
Rohde & Schwarz	Power Meter	NRP2	RF-237	04/14/2017
Rohde & Schwarz	Power Sensor	NRP-Z81	RF-282	4/12/2017
Rohde & Schwarz	Software	EMC-32 V9.25.00	N/A	N/A

8 Test Site Description

8.1 Radiated Emissions Test Site

Radiated measurements are performed in a 3m semi-anechoic chamber, which meets NSA requirements for the frequency range 30 MHz to 1000 MHz.

For measurements above 1 GHz, absorbers are laid out on the ground plane between the receiving antenna and the EUT to meet SVSWR in accordance with the requirements of ANSI C63.4:2014.

8.1.1 Radiated Measurements in 9 kHz- 30 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. A passive loop antenna is positioned at 3m from the EUT periphery. The turntable is rotated 360 degrees and the antenna height is maintained at 1m to determine the highest emissions. This was repeated in perpendicular, parallel and ground-parallel polarizations of the measurement antenna. The EUT is also rotated about its three orthogonal orientations to investigate emissions.

8.1.2 Radiated Measurements in 30 MHz- 1000 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. A linearly polarized broadband antenna is positioned at 3m from the EUT periphery. The turntable is rotated 360 degrees and the antenna height varied from 1m to 4m to determine the highest emissions. This is repeated for both horizontal and vertical polarizations of the measurement antenna. The EUT is also rotated about its three orthogonal orientations to investigate emissions.

8.1.3 Radiated Measurements above 1GHz

The EUT is positioned on a turntable at a height of 150cm using a device positioner. A linearly polarized antenna is positioned at 3m from the EUT periphery. Guidelines from ANSI C63.10: 2013 were followed with respect to maximizing the emissions. The turntable is rotated 360 degrees, the antenna height maintained at 150cm and the device positioner rotated about its horizontal axis to determine the highest emissions. This is repeated for both horizontal and vertical polarizations of the measurement antenna.

Measurements above 18GHz were performed at a distance of 3m using standard gain horn Antennas.

8.2 Antenna port conducted measurements

All antenna port conducted measurements were performed on a bench-top setup consisting of a spectrum analyzer, power meter (as necessary), attenuators, and pre-characterized RF cables.

The correction factors between the EUT and the Spectrum Analyzer is added internally in the Analyzer settings. The plots displayed account for these correction factors.

8.3 Test Setup Diagrams

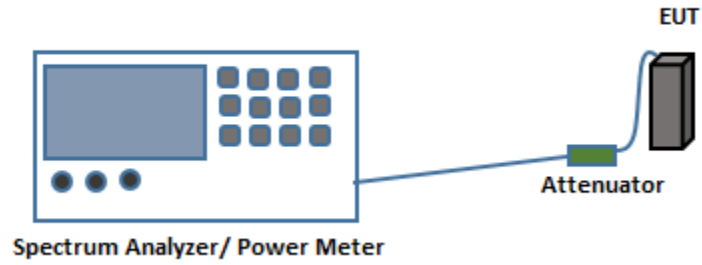


Figure 8-1. Test Setup for Antenna port conducted measurements

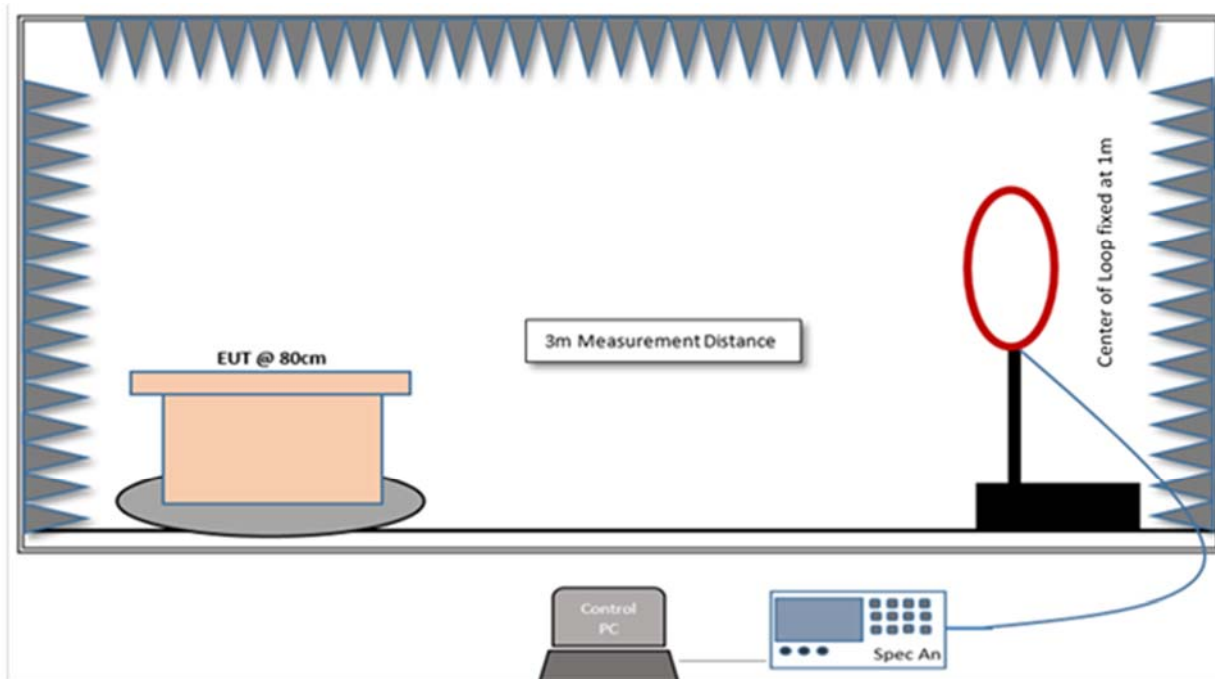


Figure 8-2. Test Setup for Radiated measurements in 9kHz - 30MHz

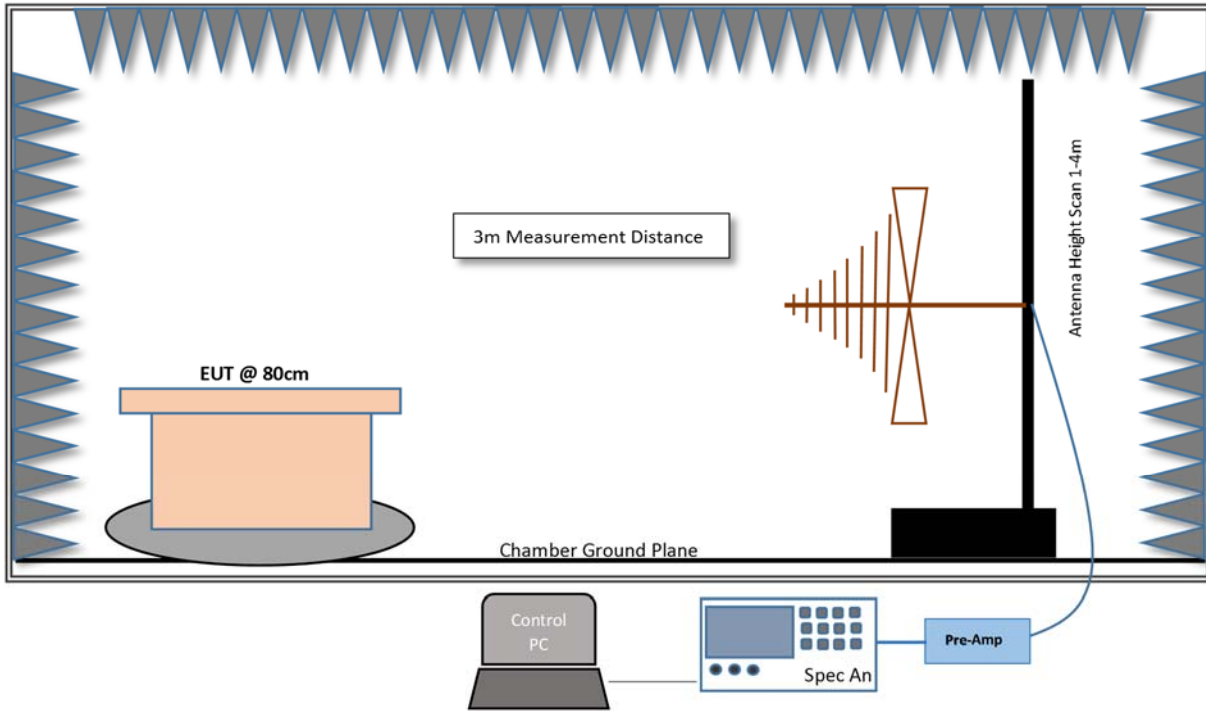


Figure 8-3. Test Setup for Radiated measurements in 30MHz- 1GHz Range

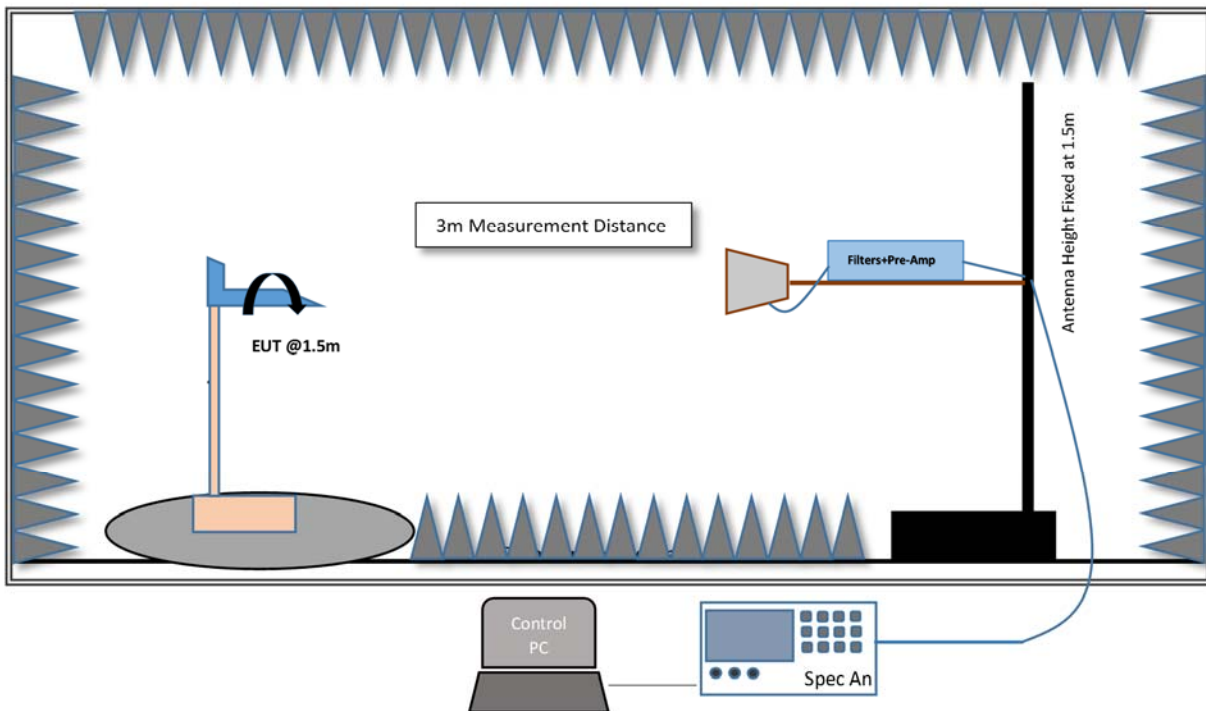


Figure 8-4. Test Setup for Radiated measurements in 1GHz- 18GHz Range

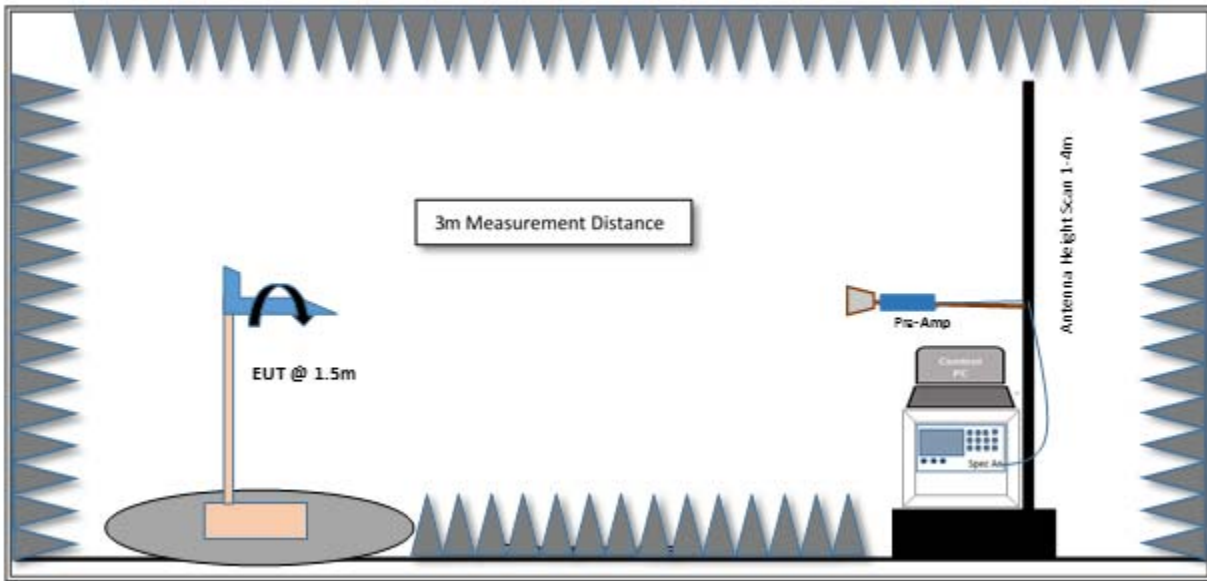


Figure 8-5. Test Setup for Radiated measurements >18GHz

9 Test Results- Conducted

9.1 Duty Cycle

9.1.1 Test Requirement:

Reporting and measurement purposes only.

9.1.2 Test Method:

Measurements were performed according to the procedure defined in ANSI C63.10 (2013) American National Standard of Procedure for Compliance Testing of Unlicensed Wireless Devices.

Spectrum Analyzer Settings:

RBW \geq Occupied Bandwidth if possible; otherwise, set RBW to the largest available value

VBW \geq RBW \geq 50/Signal Period

Detector = Peak

Span = 0 Hz

Sweep points > 100

9.1.3 Limits:

Reporting and measurement purposes only.

9.1.4 Test Results:

Frequency (MHz)	Modulation	On Time (ms)	Period (ms)	Duty Cycle (%)	Correction Factor (dB)
2402	GFSK	100	100	100	0

9.1.5 Test Data:

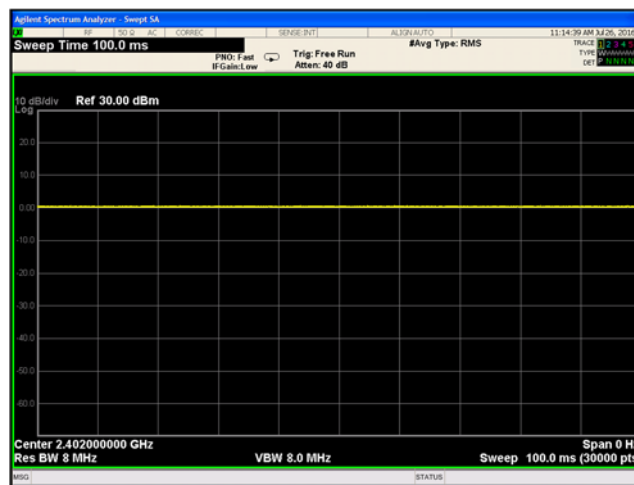


Figure 9-1. Duty Cycle 2402MHz (CH.0)

9.2 6-dB Bandwidth

9.2.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (a)(2)

Innovation Science and Economic Development Canada RSS-247 [5.2]

9.2.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R05 and ANSI C63.10: 2013.

KDB 558074 Method 8.2

Spectrum Analyzer settings:

RBW= 100 kHz

VBW> 300 kHz

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto

The in-built functionality of the Spectrum Analyzer is used to measure the 6-dB bandwidth.

9.2.3 Limits:

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

9.2.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	6dB Bandwidth (kHz)	6-dB Bandwidth Limit (kHz)	Result
2402	BT LE	0	735.4	>500	Pass
2440	BT LE	19	734.5	>500	Pass
2480	BT LE	39	729.3	>500	Pass

9.2.5 Test Data:



Figure 9-2. 6dB Bandwidth (Ch. 0)

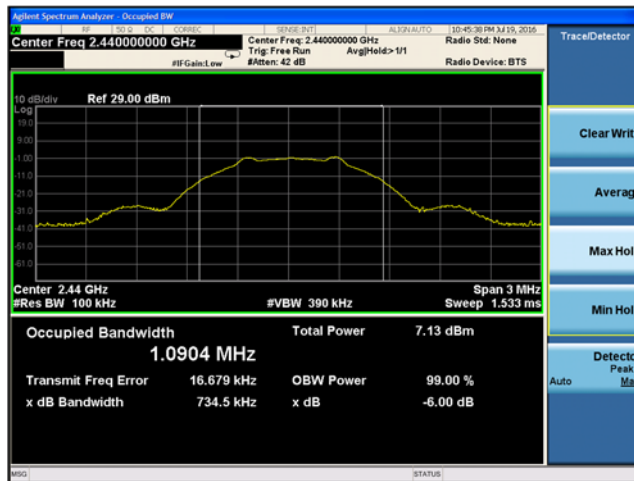


Figure 9-3. 6dB Bandwidth (Ch. 19)

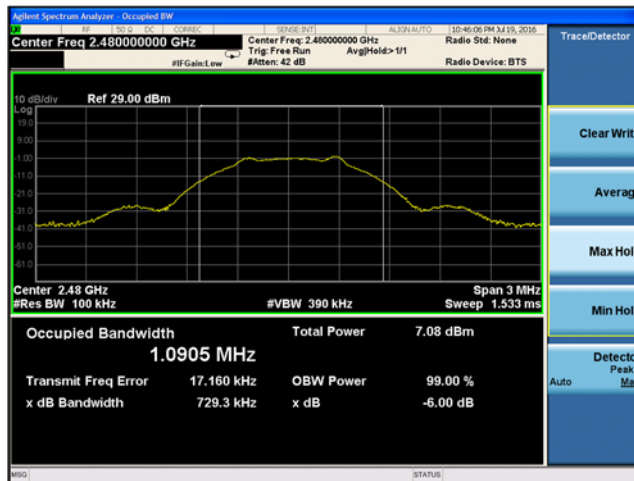


Figure 9-4. 6dB Bandwidth (Ch. 39)

9.3 Occupied Bandwidth

9.3.1 Test Requirement:

The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal.

9.3.2 Test Method:

Measurements are performed according to ANSI C63.10 (2013).

Spectrum Analyzer settings:

Set analyzer center frequency to the nominal EUT channel frequency

Span set to between 1.5 and 5.0 times the DTS bandwidth

RBW to: 1% to 5% of the OBW

VBW \geq 3 RBW

Detector = Peak

Sweep time = auto couple

Trace mode = max hold

Use the 99% power bandwidth function of the instrument.

9.3.3 Limits:

For reporting purposes only.

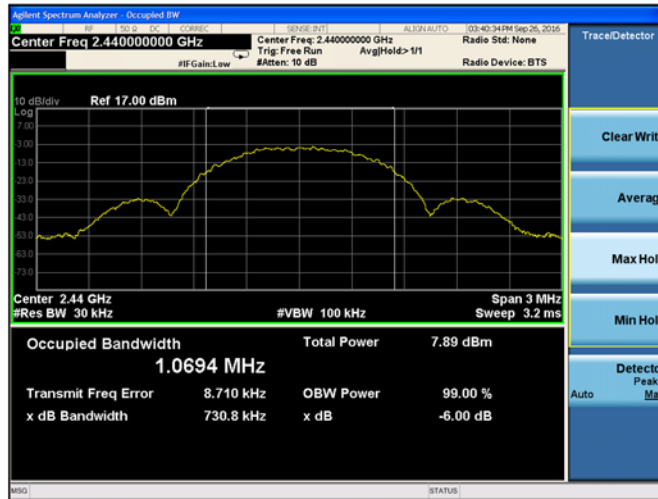
9.3.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	99% Bandwidth (MHz)
2402	BT LE	0	1.06
2440	BT LE	19	1.07
2480	BT LE	39	1.07

9.3.5 Test Data:



Plot 9-5. 99% Bandwidth (Ch. 0)



Plot 9-6. 99% Bandwidth (Ch. 19)



Plot 9-7. 99% Bandwidth (Ch. 39)

9.4 Output Power

9.4.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (b)(3)

Innovation Science and Economic Development Canada RSS-247 [5.4]

9.4.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

Peak Power:

KDB 558074 Section 9.1.1

RBW= 1 MHz

VBW= 3 MHz

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto

Span= 3 MHz

Average Power Method:

KDB 558074 Section 9.2.3.1

Antenna port conducted measurements were performed on a bench-top setup consisting of an average power meter and pre-characterized RF cables.

Total Average Power (dBm)= Measured Average Power (dBm)+ Duty Cycle Correction Factor (dB).

9.4.3 Limits:

15.247: The maximum permissible peak output power is 30 dBm (1 W).

RSS-247: The maximum peak conducted output power shall not exceed 30dBm (1 W) and the maximum radiated output power shall not exceed 36dBm (4 W) EIRP.

9.4.4 Test Results:

Maximum Conducted Peak Output Power						
Freq. (MHz)	Ch. No.	Measured Conducted Peak Power (dBm)	Measured Conducted Peak Power (W)	FCC/ISED Limit (dBm)	Margin (dB)	Result
2402	0	0.59	0.001	30	-29.41	Pass
2440	19	0.62	0.001	30	-29.38	Pass
2480	39	0.60	0.001	30	-29.40	Pass

Maximum Peak EIRP								
Freq. (MHz)	Ch. No.	Measured Conducted Peak Power (dBm)	Antenna Gain (dBi)	Calculated EIRP (dBm)	EIRP (W)	ISED Limit (dBm)	Margin (dB)	Result
2402	0	0.59	1.73	2.32	0.002	36	-33.68	Pass
2440	19	0.61	1.73	2.35	0.002	36	-33.65	Pass
2480	39	0.60	1.73	2.33	0.002	36	-33.67	Pass

Maximum Conducted Average Power							
Freq. (MHz)	Ch. No.	Measured Average Power (dBm)	Duty Cycle Correction factor (dB)	Total Average Power (dBm)	FCC/ISED Limit (dBm)	Margin (dB)	Result
2402	0	0.10	0	0.10	30	-29.90	Pass
2440	19	-0.04	0	-0.04	30	-30.40	Pass
2480	39	0.06	0	0.06	30	-29.94	Pass

9.4.5 Test Data:

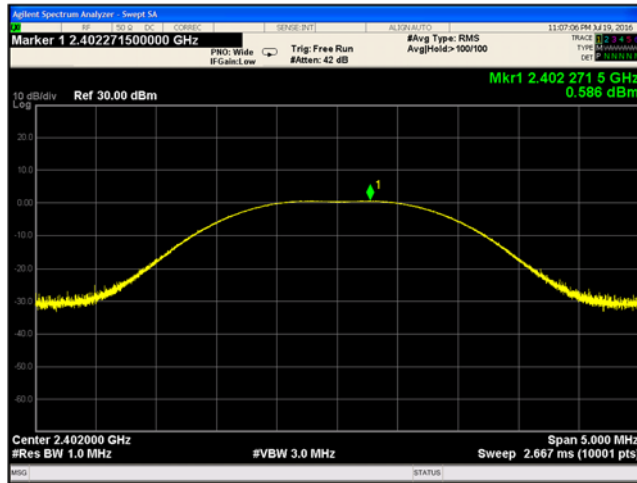


Figure 9-8. Peak Power (Ch. 0)

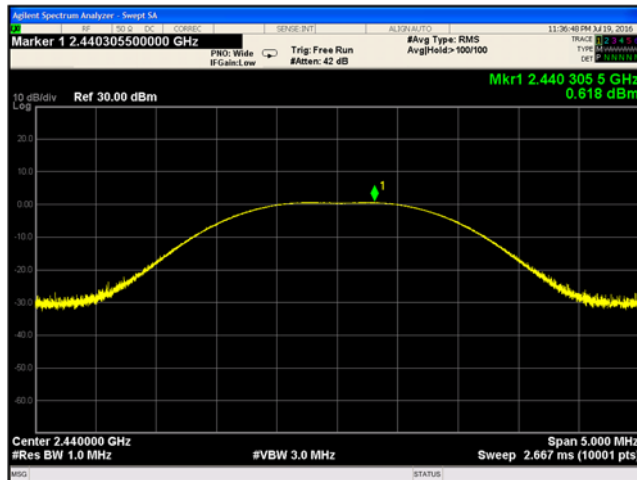


Figure 9-8. Peak Power (Ch. 19)

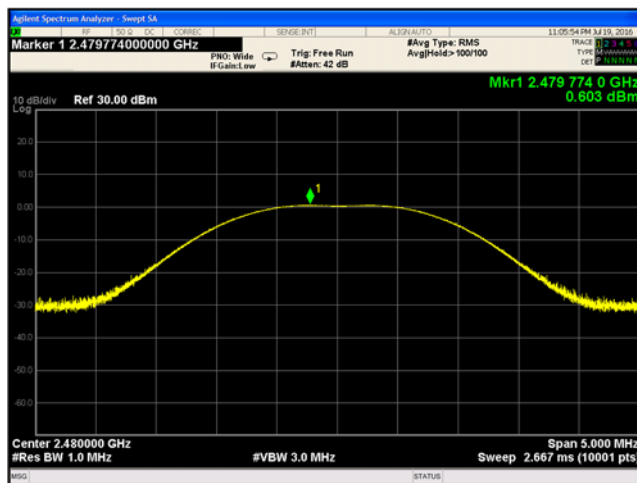


Figure 9-10. Peak Power (Ch. 39)

9.5 Peak Power Density

9.5.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (e)

Innovation Science and Economic Development Canada RSS-247 [5.2]

9.5.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

KDB 558074 Section 10.2

RBW= 100 kHz

VBW≥ 300 kHz

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto

9.5.3 Limits:

The maximum permissible power density is 8 dBm/3kHz.

9.5.4 Test Results:

Freq. (MHz)	Test Mode	Channel No.	Measured Power Spectral Density (dBm/100kHz)	Power Spectral Density Limit (dBm/3kHz)	Margin compared to Limit (dB)	Result
2402	BT LE	0	-0.23	8	-8.23	Pass
2440	BT LE	19	0.06	8	-7.94	Pass
2480	BT LE	39	-0.10	8	-8.10	Pass

The test data shows that the EUT passes the requirement using 100kHz RBW setting and therefore should meet the requirement for 3kHz RBW.

9.5.5 Test Data:

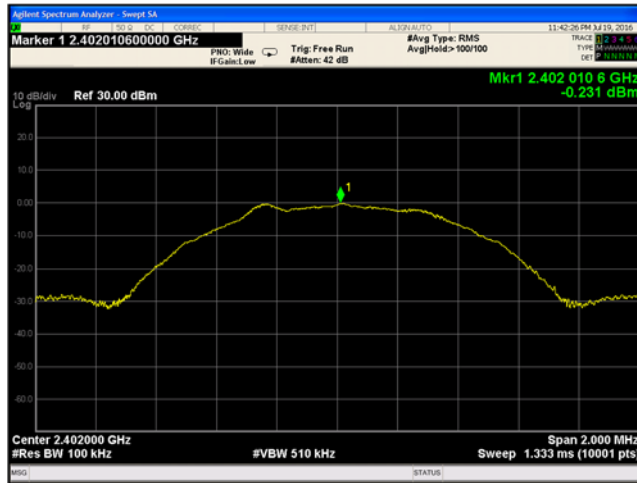


Figure 9-11. Power Spectral Density (Ch. 0)

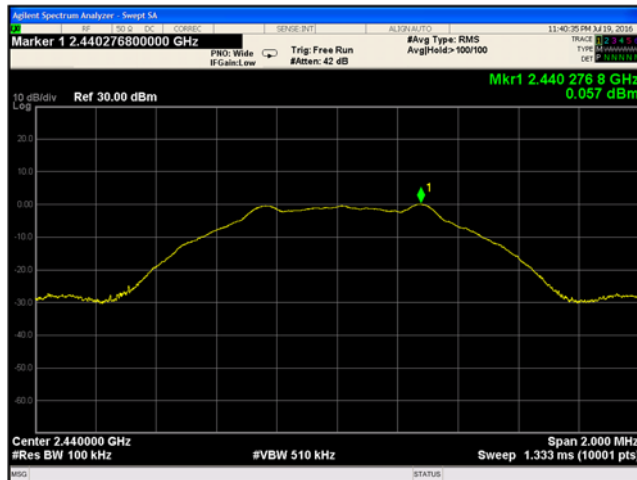


Figure 9-12. Power Spectral Density (Ch. 19)

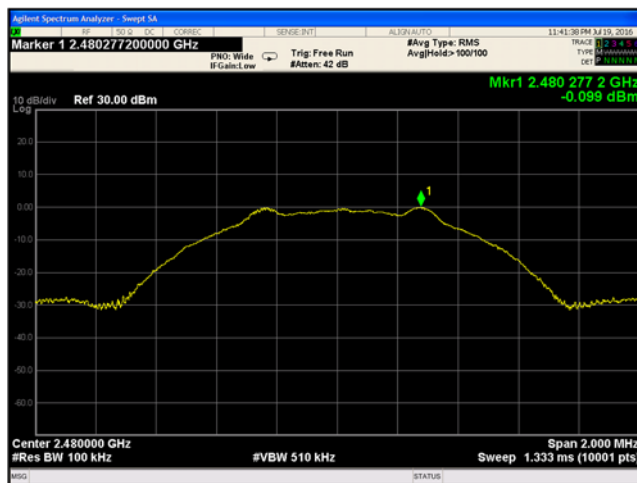


Figure 9-13. Power Spectral Density (Ch. 39)

9.6 Conducted Spurious Emissions

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

Innovation Science and Economic Development Canada RSS-247 [5.5]

9.6.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

KDB 558074 Section 11.2

Identification of Reference Level:

RBW= 100 kHz

VBW $\geq 3 \times$ RBW

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto

Span= 3 MHz

Peak Marker function to determine the max PSD level.

Conducted Spurious Emissions:

KDB 558074 Section 11.3 with Increased RBW

RBW= 1MHz

VBW $\geq 3 \times$ RBW

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto

Span= 30 MHz- 12 GHz; 12 GHz – 25 GHz

Sweep Points= 30000

9.6.3 Limits:

All spurious emissions at least 20 dBc.

9.6.4 Test Result:

Carrier Freq. (MHz)	Channel No.	Emission Frequency (MHz)	Emission Amplitude ($\frac{\text{dBm}}{\text{MHz}}$)	Reference Level ($\frac{\text{dBm}}{100 \text{ kHz}}$)	Limit ($\frac{\text{dBm}}{100 \text{ kHz}}$)	Margin (dB)	Result
2402	0	23095.00	-37.52	-0.23	-20.23	-17.29	Pass
2440	19	22725.40	-37.54	0.06	-19.94	-17.60	Pass
2480	39	22803.40	-37.74	-0.10	-20.10	-17.65	Pass

9.6.5 Test Data:

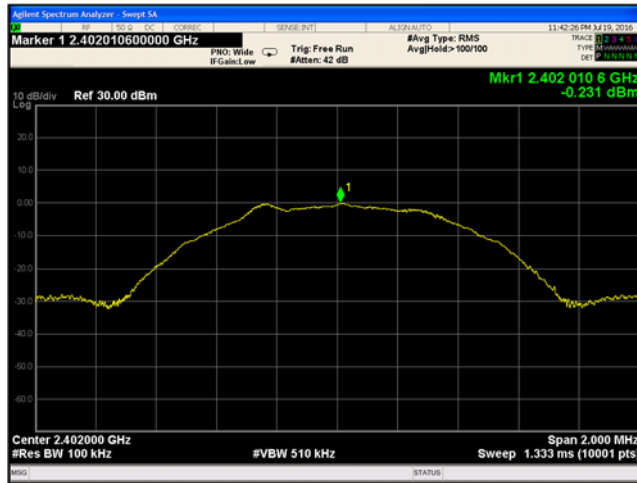


Figure 9-14. Reference Level Measurement (Ch.0)

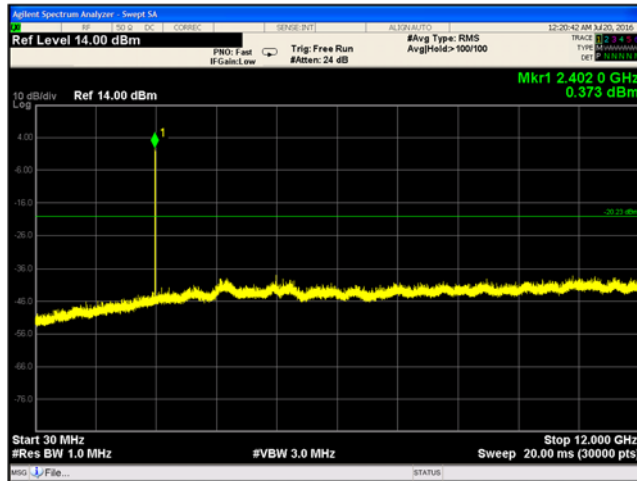


Figure 9-15. Conducted Spurious Emissions 30-12000 MHz (Ch. 0)

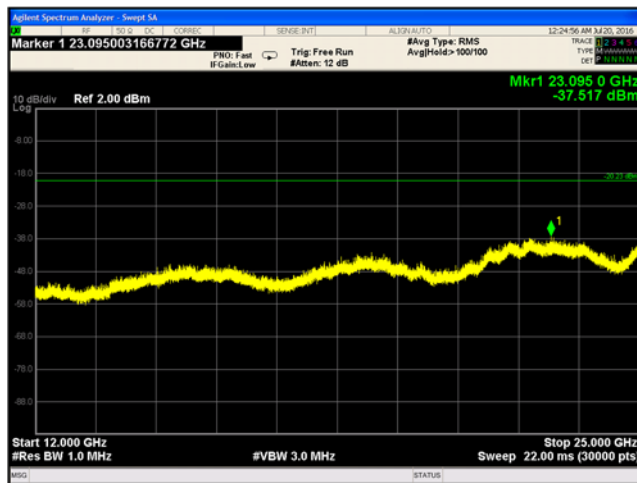


Figure 9-16. Conducted Spurious Emissions 12-25 GHz (Ch.0)

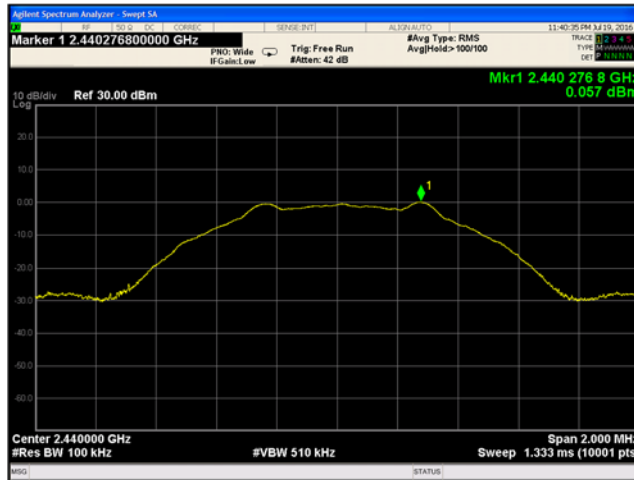


Figure 9-17. Reference Level Measurement (Ch.19)

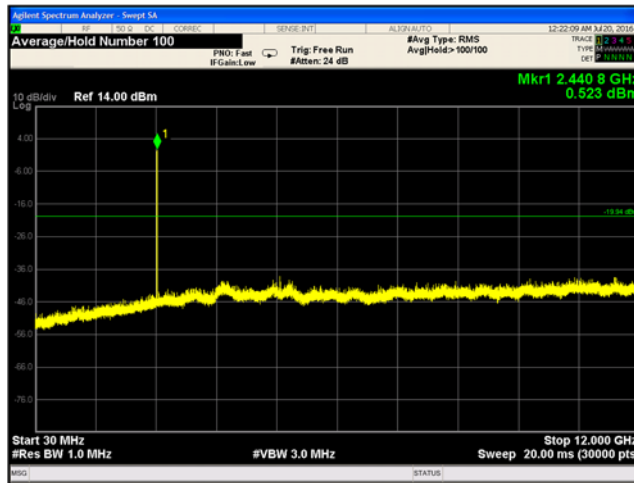


Figure 9-18. Conducted Spurious Emissions 30-12000 MHz (Ch. 19)

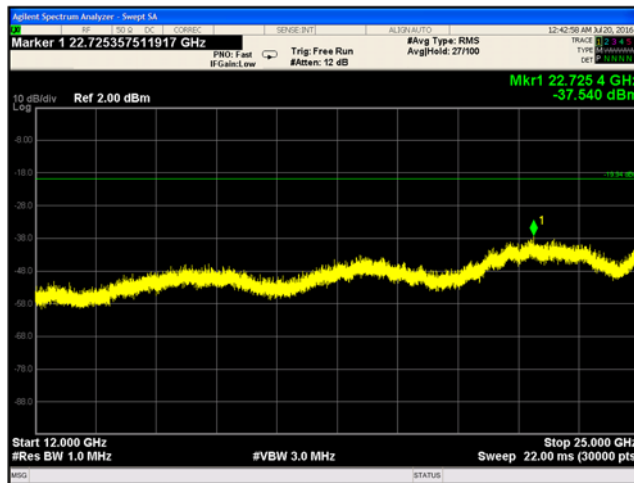


Figure 9-19. Conducted Spurious Emissions 12-25 GHz (Ch. 19)

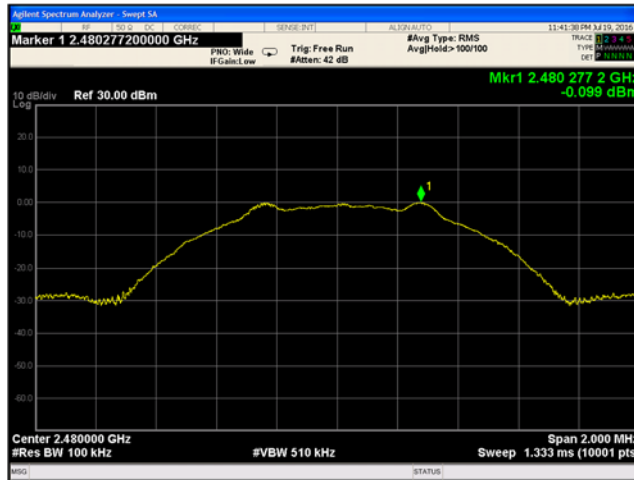


Figure 9-20. Reference Level Measurement (Ch.39)

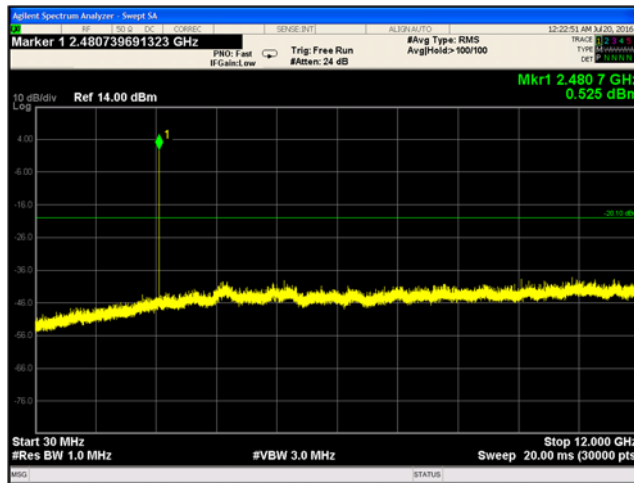


Figure 9-21. Conducted Spurious Emissions 30-12000 MHz (Ch.39)

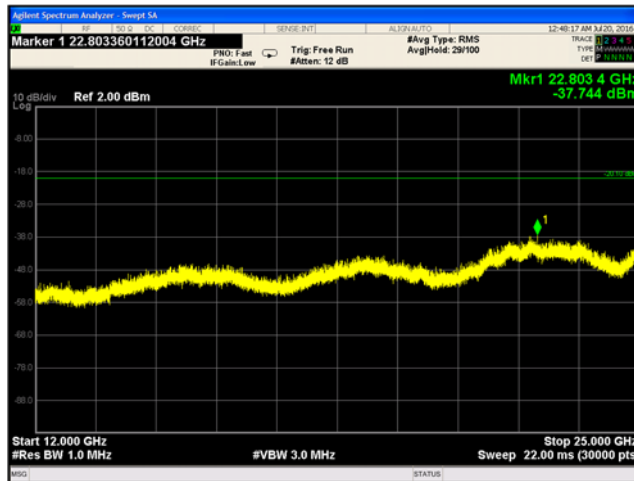


Figure 9-22. Conducted Spurious Emissions 12-25 GHz (Ch.39)

9.7 Conducted Band Edge Emissions

9.7.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

Innovation Science and Economic Development Canada RSS-247 [5.5]

9.7.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

KDB 558074 Section 11.3

Band Edge Emissions:

RBW= 100 kHz

VBW \geq 3 x RBW

Detector= Peak

Sweep time= Auto

Span = 10MHz

The trace was allowed to stabilize. The marker was set on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. The delta marker function was set and the marker-to-peak function moved to the peak of the in-band emission.

9.7.3 Limits:

All spurious emissions at least 20 dBc.

9.7.4 Test Result:

Carrier Freq. (MHz)	Channel	Emission Frequency (MHz)	Emission Amplitude $\left(\frac{\text{dBm}}{100 \text{ kHz}}\right)$	Reference Level $\left(\frac{\text{dBm}}{100 \text{ kHz}}\right)$	Limit $\left(\frac{\text{dBm}}{100 \text{ kHz}}\right)$	Margin (dB)	Result
2402	0	2399.98	-50.76	-0.23	-20.23	-30.53	Pass
2480	39	2485.94	-51.69	-0.10	-20.10	-31.59	Pass

9.7.5 Test Data:

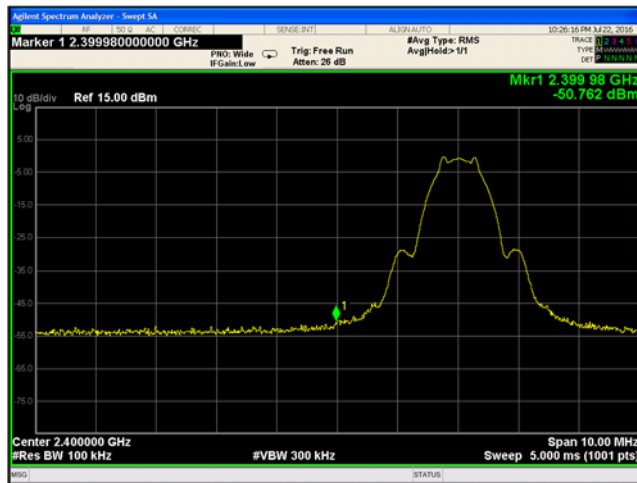


Figure 9-23. Conducted-Low Band Edge (Ch. 0)

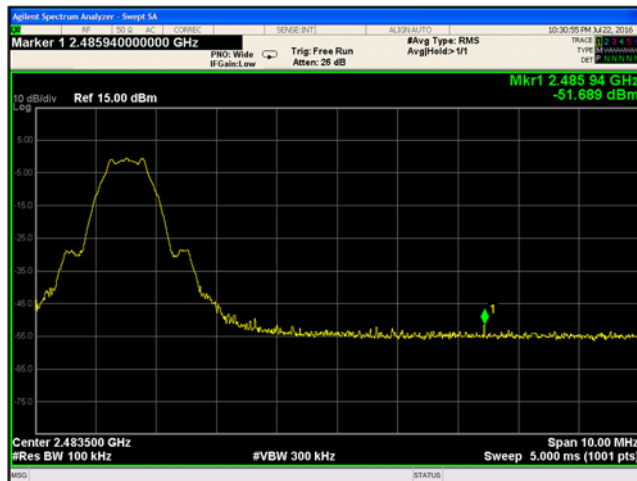


Figure 9-24. Conducted- High Band Edge (Ch. 39)

10 Test Results- Radiated

10.1 Radiated Spurious and Band Edge Emissions

10.1.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

Innovation Science and Economic Development Canada RSS-247 [5.5] and RSS GEN [8.9]

10.1.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R05 and ANSI C63.10: 2013. Measurements in the 9 kHz- 30 MHz range is performed according to guidelines in ANSI C63.10:2013 and following requirements per KDB 937606.

Radiated spurious measurements were made from 9 kHz to the 10th harmonic of the fundamental frequency of the transmitter. The limit for radiated spurious emissions is per 15.209 and RSS-Gen. Additionally, emissions found in the restricted bands as listed in 15.205 were tested for compliance per limits in 15.209 and RSS-Gen.

The EUT was tested near the low, middle and high channels of operation. Guidelines in ANSI C63.10 2013 were followed with respect to maximizing the emission by rotating the EUT about its vertical and horizontal axis and adjusting the measurement antenna polarization. Worst case maximized data is shown in this test report.

A pre-amp and a high pass filter were required for this test, in order to provide the measuring system with sufficient sensitivity. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength.

Sample Calculation:

Field Strength Level: Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) – Amplifier Gain = 50 dB μ V + 33 dB – 25 dB = 58dB μ V/m

Spectrum Analyzer Settings:

Radiated Spurious Emissions

9 kHz- 30 MHz:

RBW= 1 kHz | 10kHz

VBW \geq 3 X RBW

Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector.

Span= 9kHz – 150kHz and 150kHz- 30 MHz

Sweep time= Auto

30 MHz- 1 GHz:

RBW= 100 kHz

VBW \geq 3 X RBW

Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector.

Span= 30 MHz- 1 GHz

Sweep time= Auto

Above 1 GHz:

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold) and RMS Average Detector (Max Hold)

Span= 1- 18 GHz and 18- 26.5 GHz.

Sweep time= Auto

Spectrum Analyzer Settings:
Restricted Band-Edge Emissions

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold) and RMS Average Detector (Max Hold)

Span= 2310 – 2500 MHz

Sweep Points = 801

Sweep Time = Peak: Auto; Average: 100 s

10.1.3 Limits:

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$)	Measurement Distance (meters)	Corrected Field Strength for 3m measurement distance ($\text{dB}\mu\text{V}/\text{m}$)
0.009-0.490	2400/F (kHz)	300	48.5- 13.8
0.490-1.705	24000/F (kHz)	30	33.8- 23.0
1.705-30	30	30	29.5
30-88	100	3	40
88-216	150	3	43.5
216-960	200	3	46
960-1000	500	3	54
Above 1000	500	3	54 (Average) 74 (Peak)

For emissions outside the restricted bands, the 20dBc limit is applied.

10.1.4 Test Result:

Pass.

10.1.5 Test Data:

10.1.5.1 Emissions in 9 kHz- 30 MHz range

Preliminary measurements showed that there were no significant emissions or no emissions above the noise floor below 30MHz and therefore no final measurements were made.

10.1.5.2 Emissions in 30 MHz- 1 GHz range

RSE 30-1000 MHz						
Carrier Frequency (MHz)	Spurious Emission Frequency (MHz)	Raw Quasi-Peak Amplitude (dB μ V/m)	Correction Factor (dB)	Corrected Quasi-Peak Field Strength (dB μ V/m)	Quasi-Peak Limit (dB μ V/m)	Quasi-Peak Margin (dB)
2402	30.23	3.00	23.40	26.40	40	-13.60
2402	42.23	2.49	19.10	21.59	40	-18.41
2402	122.26	2.42	20.20	22.62	43.50	-20.88
2402	484.68	2.77	25.20	27.97	46	-18.03
2402	660.72	4.60	27.70	32.30	46	-13.70
2402	946.44	4.27	30.90	35.17	46	-10.83
2440	30.01	3.00	23.50	26.50	40	-13.50
2440	95.30	2.30	15.90	18.20	43.5	-25.30
2440	195.12	3.16	18.60	21.76	43.5	-21.74
2440	523.24	2.94	25.80	28.74	46	-17.26
2440	704.85	4.41	28.30	32.71	46	-13.29
2440	868.29	4.19	30.10	34.29	46	-11.71
2480	30.26	3.00	23.40	26.40	40	-13.46
2480	926.65	4.24	30.60	34.84	46	-11.16

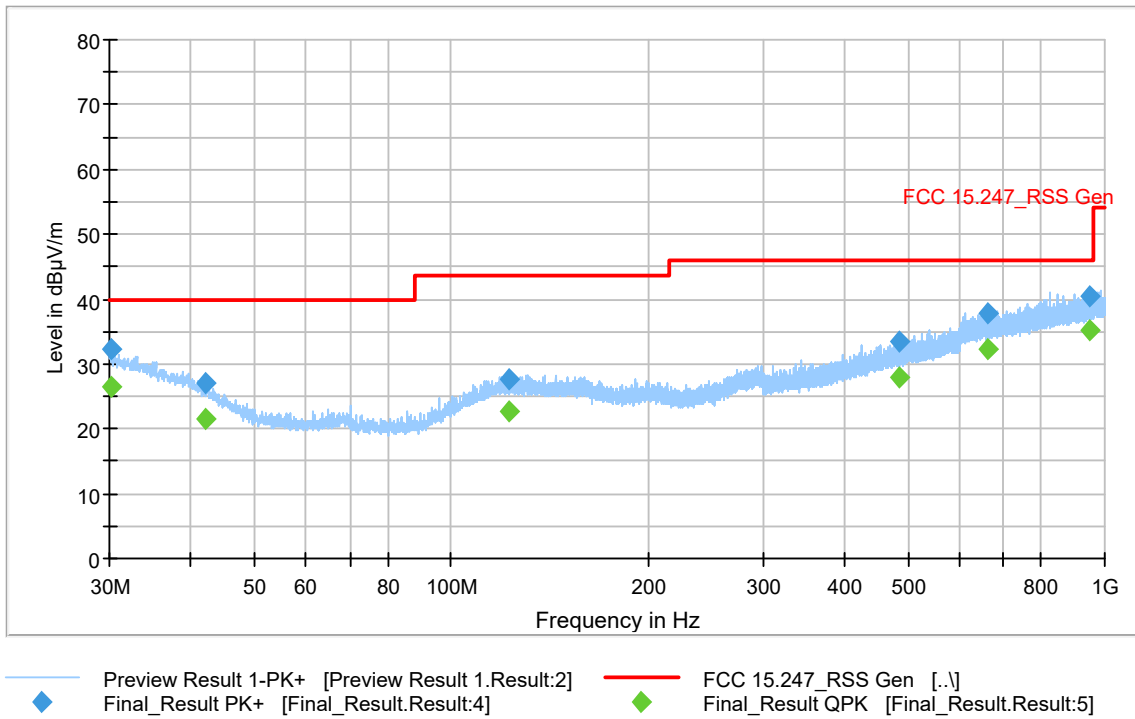


Figure 10-1. Radiated Spurious Emissions (Ch.0) (30 MHz – 1 GHz)

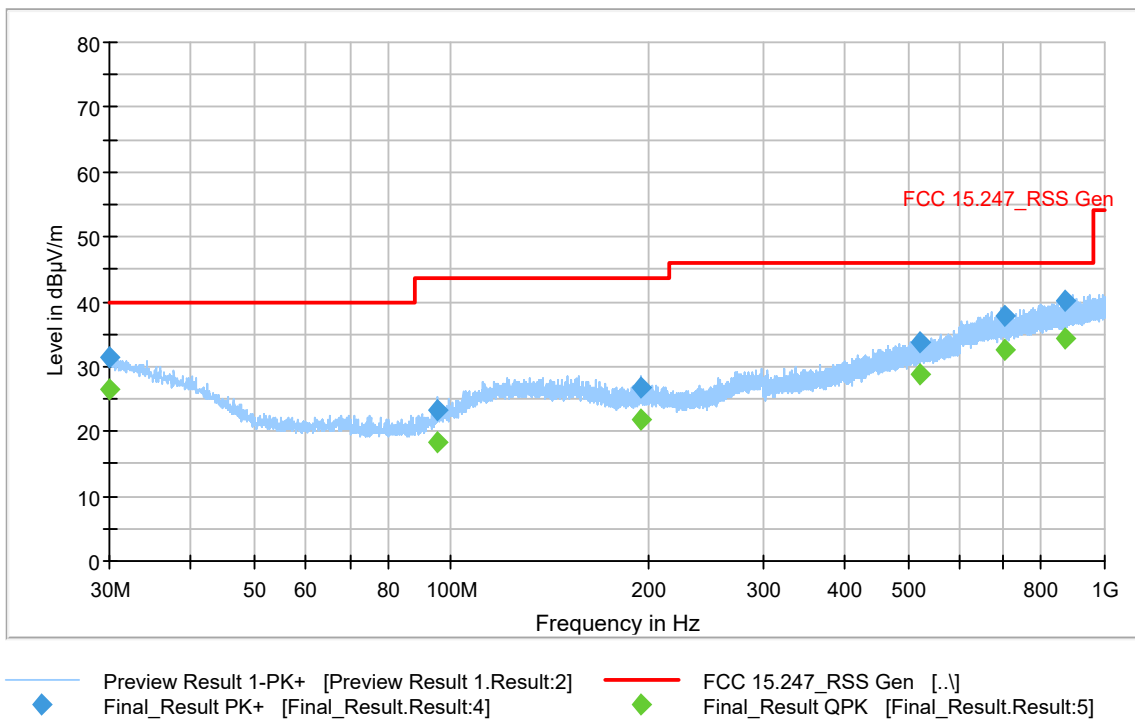
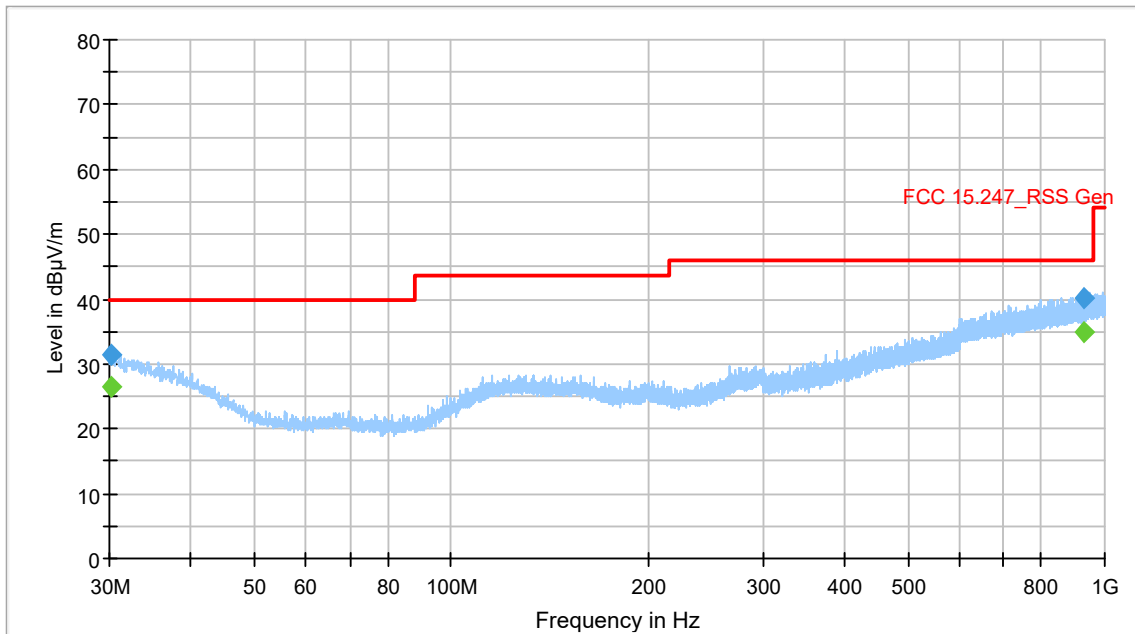


Figure 10-2. Radiated Spurious Emissions (Ch.39) (30 MHz – 1 GHz)



◆ Preview Result 1-PK+ [Preview Result 1.Result:2]
 — FCC 15.247_RSS Gen [..]

◆ Final_Result PK+ [Final_Result.Result:4]
 ◆ Final_Result QPK [Final_Result.Result:5]

Figure 10-3. Radiated Spurious Emissions (Ch.19) (30 MHz – 1 GHz)

10.1.5.3 Emissions in 1-18 GHz range

RSE 1 - 18GHz Average Data							
Carrier Frequency (MHz)	Spurious Emission Frequency (MHz)	Raw Avg. Amplitude (dBµV)	Correction Factor (dB)	Duty Cycle Correction (dB)	Corrected Avg. Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)
2402	No emissions were observed above the noise floor						
2440	1276.80	25.25	8.50	0	33.75	54	-20.25
2440	3752.60	23.92	7.10	0	31.02	54	-22.98
2440	4879.80	26.83	8.00	0	34.83	54	-19.17
2480	4959.60	29.37	9.40	0	38.77	54	-15.22

RSE 1 - 18GHz Peak Data							
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	
2402	No emissions were observed above the noise floor						
2440	1291.60	38.04	8.40	46.44	74	-27.56	
2440	3761.20	34.63	6.80	41.43	74	-32.57	
2440	4548.20	34.57	8.10	42.67	74	-31.33	
2440	4884.6	35.15	8.20	43.35	74	-30.65	
2480	4959.6	36.65	9.40	46.05	74	-27.95	

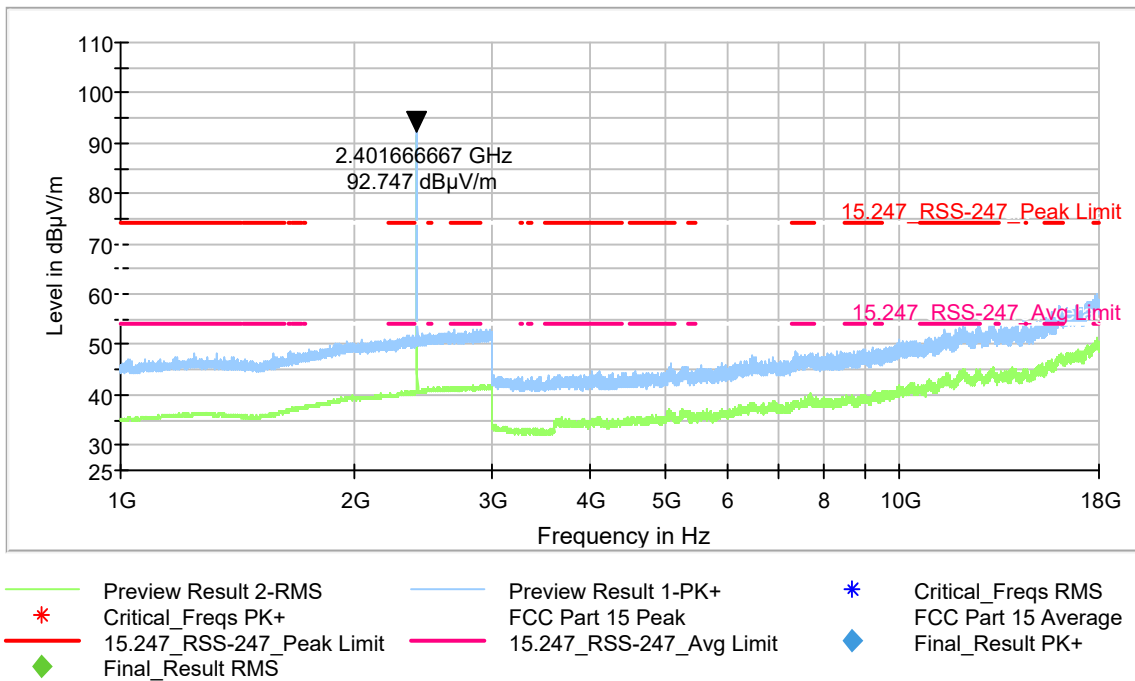
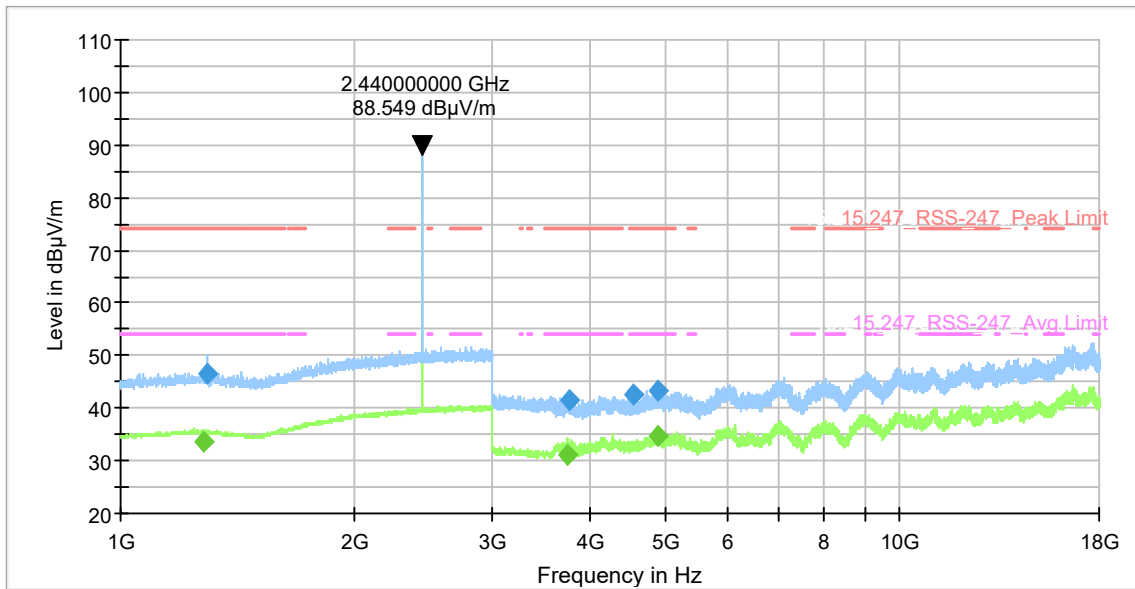
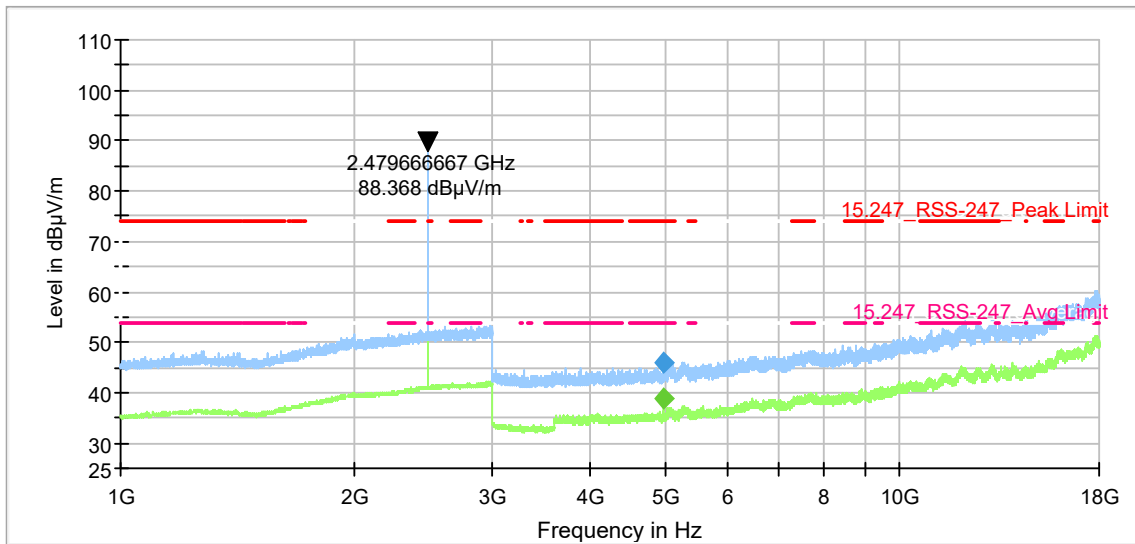


Figure 10-4. Radiated Spurious Emissions 1-18 GHz (Ch. 0)



— Preview Result 2-RMS [Preview Result 2.Result:4] — Preview Result 1-PK+ [Preview Result 1.Result:2]
— 15.247_RSS-247_Peak Limit_inv [..] — 15.247_RSS-247_Avg Limit_inv [..]
— 15.247_RSS-247_Peak Limit [..] — 15.247_RSS-247_Avg Limit [..]
◆ Final_Result PK+ [Final_Result.Result:4] ◆ Final_Result RMS [Final_Result.Result:5]

Figure 10-5. Radiated Spurious Emissions 1-18 GHz (Ch. 19)

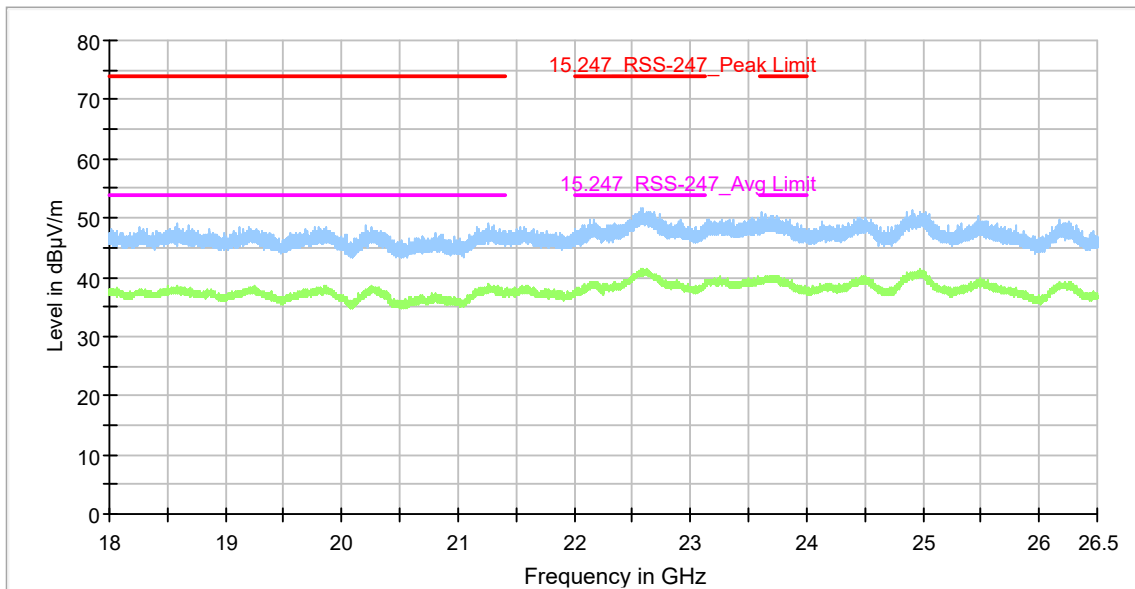


— Preview Result 2-RMS — Preview Result 1-PK+ — FCC Part 15 Peak
— FCC Part 15 Average — 15.247_RSS-247_Peak Limit — 15.247_RSS-247_Avg Limit
◆ Final_Result PK+ ◆ Final_Result RMS

Figure 10-6. Radiated Spurious Emissions 1-18 GHz (Ch. 39)

10.1.5.4 Emissions in 18-26.5 GHz range

No significant emissions to report above noise floor.



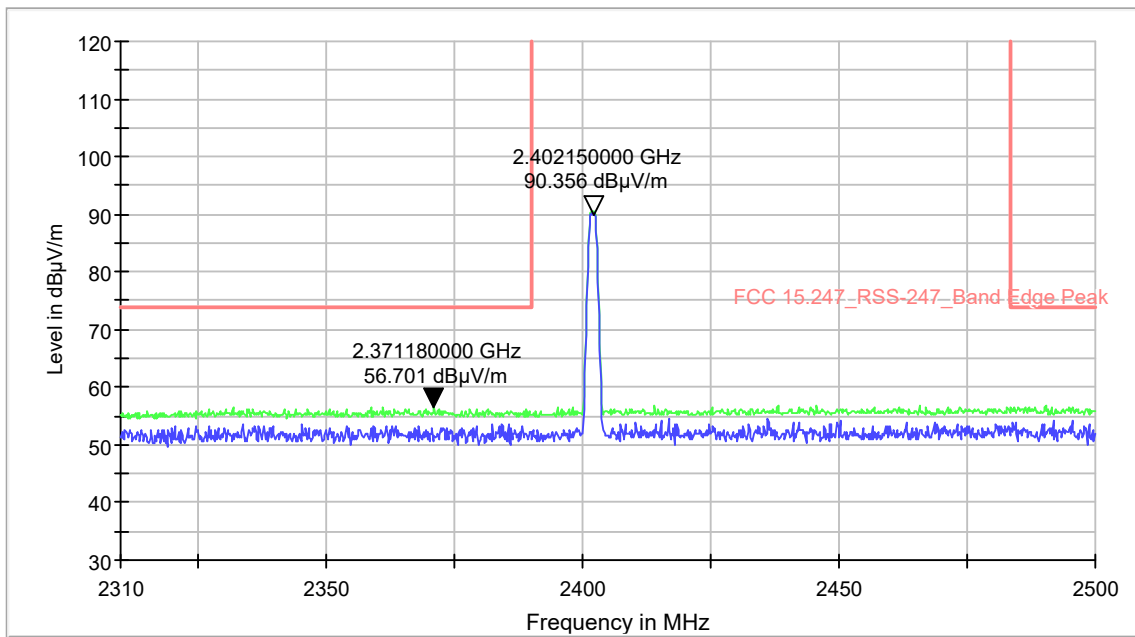
- | | |
|---|--|
| — Preview Result 2-RMS [Preview Result 2.Result:4] | — Preview Result 1-PK+ [Preview Result 1.Result:2] |
| * Critical_Freqs RMS [Critical_Freqs.Result:5] | * Critical_Freqs PK+ [Critical_Freqs.Result:4] |
| — 15.247_RSS-247_Peak Limit [..] | — 15.247_RSS-247_Avg Limit [..] |
| ◆ Final_Result PK+ [Final_Result.Result:4] | ◆ Final_Result RMS [Final_Result.Result:5] |

Figure 10-7. Radiated Spurious Emissions 18-26.5 GHz (Ch. 39)

10.1.5.5 Radiated restricted Band-edge emissions

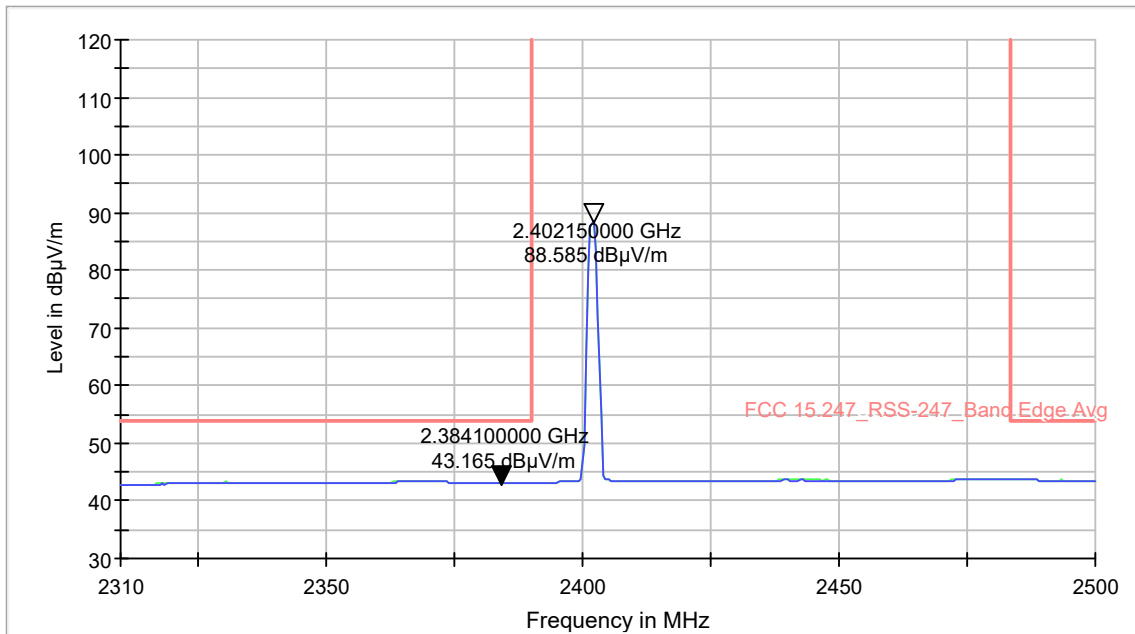
Radiated Restricted Band-edge Emissions						
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBμV)	Correction Factor (dB)	Corrected Peak Field Strength (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)
2402	2371.18	43.56	13.14	56.70	74	-17.30
2480	2493.35	43.65	13.25	56.90	74	-17.10

Radiated Restricted Band-edge Emissions							
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dBμV)	Correction Factor (dB)	DCF (dB)	Corrected Avg. Field Strength (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)
2402	2384.10	30.20	12.97	0	43.17	54	-10.83
2480	2492.40	30.34	13.25	0	43.59	54	-10.41



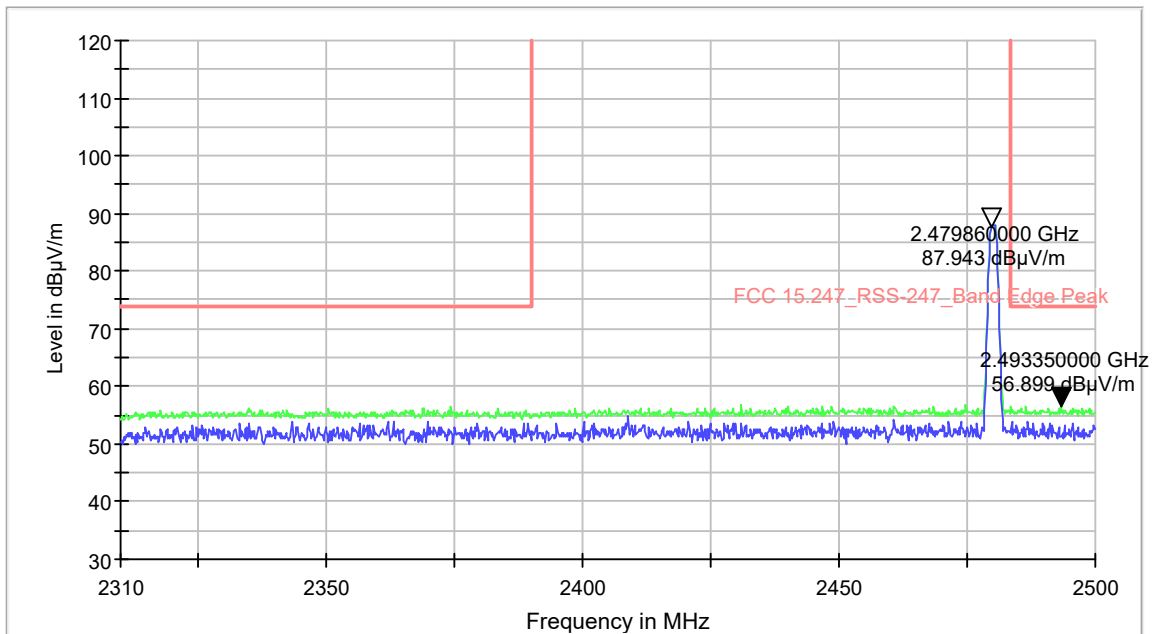
— PK+_MAXH-PK+ [Result Table.Result:2]
— FCC 15.247 Band Edge Peak [..]
— PK+_CLRWR-PK+ [Result Table.Result:1]
— FCC 15.247_RSS-247_Band Edge Peak [..]

Figure 10-8. Radiated Restricted Band Edge (Ch. 0) Peak



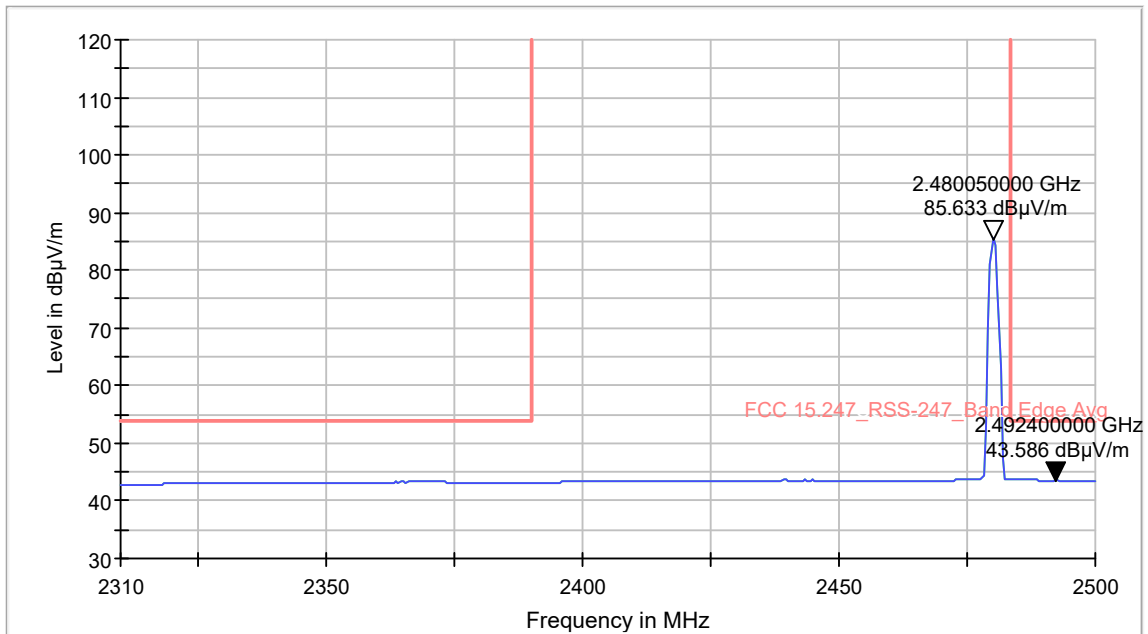
— RMS_MAXH-RMS [Result Table.Result:2] — RMS_CLRWR-RMS [Result Table.Result:1]
— FCC 15.247_Band Edge Avg [...] — FCC 15.247_RSS-247_Band Edge Avg [...]

Figure 10-9. Radiated Restricted Band Edge (Ch. 0) Average



— PK+_MAXH-PK+ [Result Table.Result:2] — PK+_CLRWR-PK+ [Result Table.Result:1]
— FCC 15.247_Band Edge Peak [...] — FCC 15.247_RSS-247_Band Edge Peak [...]

Figure 10-10. Radiated Restricted Band Edge (Ch. 39) Peak



— RMS_MAXH-RMS [Result Table.Result:2] — RMS_CLRWR-RMS [Result Table.Result:1]
FCC 15.247 Band Edge Avg [..] FCC 15.247_RSS-247_Band Edge Avg [..]

Figure 10-11. Radiated Restricted Band Edge (Ch. 39) Average

11 AC Line Conducted Emissions

11.1.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)

Innovation Science and Economic Development Canada RSS Gen [8.8]

11.1.2 Test Method

Conducted power line measurements are made over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly) connected to a public power network. The measurements were made using a LISN (Line Impedance Stabilization Network).

The EUT has a USB port and is not supplied with a specific AC/DC adapter. An off-the-shelf adapter and USB cable were used for this test. The EUT is set to continuously transmit on Ch.19.

EMI Receiver Settings:

150 kHz – 30 MHz:

RBW= 9 kHz

VBW \geq 3 X RBW

Trace Mode: Peak Detector (Max Hold).

Final measurements were performed using Quasi-Peak and Average Detectors.

Span= 150 kHz – 30 MHz

Sweep time= Auto

11.1.3 Limit

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

11.1.4 Test Result:

Not Applicable

11.1.5 Test Data:

Not Applicable: The EUT is battery powered only, and does not connect directly to the AC mains

End of Report