RADIO TEST REPORT

For

MODEL NO.: 1707
FCC ID: C3K1707
IC ID: 3048A-1707

Test Report No. R-TR371-FCCIC-BT-4
Issue Date: 24 Oct 2016

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

Prepared by
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ACCREDITED
TESTING CERT #3472.01

1 Record of Revisions

Revision	Date	Section	Page(s)	Summary of Changes	Author/Revised By:
1.0	09/23/2016	All	All	Version 1.0	Daniel Salinas
2.0	10/14/2016	5 7 9.2	8 12 18	Updated Product description. Corrected Equipment list details for CE Test. Added 99% Occupied bandwidth results.	Daniel Salinas
3.0	10/17/2016	5	8	Updated Antenna Gain information.	Daniel Salinas
4.0	10/24/2016	7	11	Corrected typo with Murata and MegaPhase RF Cable details.	Daniel Salinas

Table of Contents

Test Report Attestation

Microsoft Corporation
Model: 1707
FCC ID: C3K1707
IC ID: 3048A-1707

Applicable Standards

Specification	Test Result
FCC 47CFR 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-TR371-FCCIC-BT-3 issued by Microsoft EMC Labs on 10/17/2016.

Written By: Daniel Salinas

Radio Test Lead

Reviewed/ Issued 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 and other equivalent applicable standards.
Test site requirements for measurements above 1 GHz are in accordance with ANSI C63.4:2014.
ANSI C63.10:2013 and the appropriate KDB test methods were followed.

4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the product, as specified in ETSI TR 100 028. This represents an expanded uncertainty expressed at 95% confidence level using a coverage factor k=2. These levels are for reference only and not included to determine product compliance.
Expanded uncertainty calculations are available upon request.

Test item	Uncertainty	Unit
Radiated disturbance (30 MHz to 1 GHz)	5.99	dB
Radiated disturbance (1 GHz to 18 GHz)	5.12	dB
Conducted Disturbance at Mains Port	3.31	dB
Uncertainty for Conducted Power test	1.277	dB
Uncertainty for Conducted Spurious emission test	2.742	dB
Uncertainty for Bandwidth test	4.98	kHz
Uncertainty for DC power test	0.05	%
Uncertainty for test site temperature	0.5	ºC
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:	Jennifer Liu
Functional Description of the EUT:	PC with IEEE 802.11a/b/g/n/ac MIMO supporting 20/40/80 MHz bandwidths, Bluetooth and additional 802.11n Radio.
Model:	1707
FCC ID:	C3K1707
IC ID:	3048A-1707
Radio under test:	BT (2402- 2480 MHz)
Modulation(s):	GFSK, π/4-DQPSK, 8PSK
Antenna Information:	Internal Antenna. **Manufacturer declared max Antenna Gain in 2.4GHz band of operation:** 1.01 dBi
EUT Classification:	FHSS
Equipment Design State:	Prototype/Production Equivalent
Equipment Condition:	Good
Test Sample Details:	RF Conducted Test Sample SN: 000074361258 RF Radiated Test Sample SN: 000266762258

5.1 Test Configurations

Test software “WiFi Tool” (V2.7.3) provided by the customer and “Lab Tool” (V2.0.0.77) from the module vendor was used to program the EUT to transmit continuously.
The device can operate in GFSK, π/4DQPSK and 8DPSK modulations and all modes were tested and included in this report. Channel numbers 0, 39 and 78 were used as Low, Mid and High Channels respectively.

5.2 Environmental Conditions

Ambient air temperature of the test site was within the range of 10 ºC to 40 ºC (50 ºF to 104 ºF) 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 antennas are permanently attached and there are no provisions for connection to an external antenna.

5.4 Equipment Modifications

No modifications were made during testing.

5.5 Dates of Testing

Testing was performed on June 9, 2016- Aug 02, 2016.

6 Test Results Summary

Test Description	FCC Rule Part ISED Rule Part	Limit	Test Result (Pass/Fail)
Duty Cycle	Reporting & Measurements	Reporting & Measurements Purposes only	N/A
20dB Bandwidth	15.247 (a)(1)(iii) RSS-247 [5.1]	For reporting purposes only.	Pass
Output Power	15.247 (b)(3) RSS-247 [5.4]	< 1 Watt – Conducted < 4 Watt - EIRP	Pass
Channel Spacing	15.247 (a)(1) RSS-247 [5.1]	2/3 of 20dB BW or 25 kHz	Pass
Number of Hopping Frequencies	15.247 (a)(1)(iii) RSS-247 [5.1]	> 15 channels	Pass
Dwell Time	15.247 (a)(1)(iii) RSS-247 [5.1]	< 0.4 sec in 31.6 sec period	Pass
Conducted Band Edge/Spurious Emissions	15.247 (d) RSS-247 [5.5]	Atleast 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 Powerline Conducted Emissions	15.207 RSS-Gen [8.8]	FCC CFR 47 15.207 limits RSS-Gen [8.8]	Pass

7 Test Equipment List

Equipment used for Radiated and Conducted Measurements				
Manufacturer	**Description**	**Model #**	**Asset #**	**Calibration Due**
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-192	4/13/2017
Rohde & Schwarz	EMI Test Receiver	ESU40	EMC-607	05/26/2017
Rohde & Schwarz	Signal Analyzer	FSV40	RF-228	4/12/2017
Rohde & Schwarz	Power Meter	NRP-Z91	RF-211	4/113/2017
Sunol Sciences	Antenna - Broadband Hybrid	JB6	EMC-640	9/29/2016
ETS-Lindgren	Antenna	3117	RF-137	2/25/2017
ETS-Lindgren	Antenna – Standard Gain	3160-09	RF-037	3/15/2017
Rohde & Schwarz	Custom Filter Bank+PreAmp	SFUNIT RX	RF-323	12/10/2016
Rohde & Schwarz	Pre-Amp	TS-PR26	RF-199	12/15/2016
Rohde & Schwarz	Switch and Control Unit	OSP130	RF-249	12/10/2016
Rohde & Schwarz	Switch and Control Unit	OSP130	RF-018	12/18/2016
Rohde & Schwarz	Switch and Control Unit	OSP150	RF-250	12/10/2016
Rohde & Schwarz	Switch and Control Unit	OSP150	RF-019	12/18/2016
Murata	RF Cable	MXHQ87WA3000	RF-415	11/09/2016
MegaPhase	RF Cable	EMC3-N1N1-394	EMC-1034	06/21/2017
Huber & Suhner	RF Cable	SucoFlex 100	RF-350	12/10/2016
Huber & Suhner	RF Cable	SucoFelx 100	RF-352	12/10/2016
Huber & Suhner	RF Cable	SucoFlex 100	RF-350	12/10/2016
Huber & Suhner	RF Cable	SucoFelx 100	RF-352	12/10/2016

Manufacturer	Description	Model #	Asset #	Calibration Due
Huber & Suhner	RF Cable	Sucoflex 102A	RF-269	12/16/2016
Madge Tech	THP Monitor	PRH Temp 2000	EMC-681	11/19/2016
Micro-Coax	RF Cable	UFA210A-0-0787-300300	RF-292	11/10/2016
Micro-Coax	RF Cable	UTI Flex	RF-354	12/10/2016
Pasternack	Attenuator	PE7087-3	RF-337	01/26/2017
Pasternack	3dB Attenuator	PE7087-3	RF-338	01/29/2017
Pasternack	6dB Attenuator	PE7087-6	RF-432	01/27/2017

Equipment used for Line Conducted Emissions Measurement				
Manufacturer	**Description**	**Model #**	**Asset #**	**Calibration Due**
Rohde & Schwarz	EMI Test Receiver	ESR 3	EMC-669	4/14/2017
Teseq	AE LISN	NNB 51	EMC-187	9/25/2016*
Teseq	Test LISN	NNB 51	EMC-642	11/24/2016
Micro-Coax	RF Cable	UFA210A-1-1800-50U50U	EMC-367	8/6/2016*
Madge Tech	THP Monitor	PRHTemp2000	EMC-169	8/18/2016*
ETS	TILE SW	Ver 7.1.3.22	N/A	N/A
Fluke	Multimeter	189	EMC-231	8/31/2016*

*Note- all equipment in valid calibration status at the time of test- Jun 29, 2016.

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 of 30MHz to 1000MHz. For measurements above 1 GHz, absorbers are laid out on the ground plane between the receiving antenna and the EUT to meet Site VSWR requirements in accordance with ANSI C63.4:2014.

8.1.1 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. All possible orientations of the EUT were investigated for emissions and the vertical standing mode was identified as the worst case configuration.

8.1.2 Radiated Measurements above 1GHz

The EUT is positioned on a Turntable at a height of 150cm. A linearly polarized antenna is positioned at 3m from the EUT periphery. Guidelines in ANSI C63.10:2013 were followed with respect to maximizing the emissions. The turntable is rotated 360 degrees and the antenna height varied from 1m to 4m (with antenna bore-sighting enabled) 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.

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), splitters/combiners (as necessary), attenuators, and pre-characterized RF cables.

The correction factors between the EUT and the spectrum analyzer were added internally in the analyzer settings, where applicable. The plots displayed takes into account these correction factors.

8.3 Test Setup Diagrams

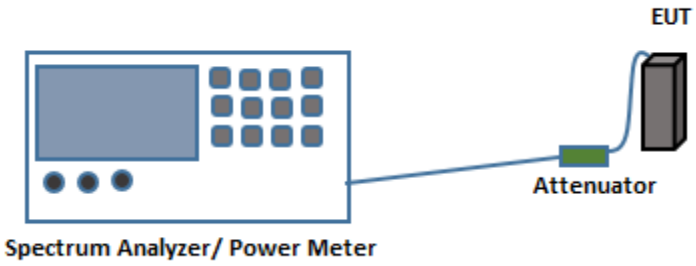


Fig.1. Test Setup for Antenna port conducted measurements

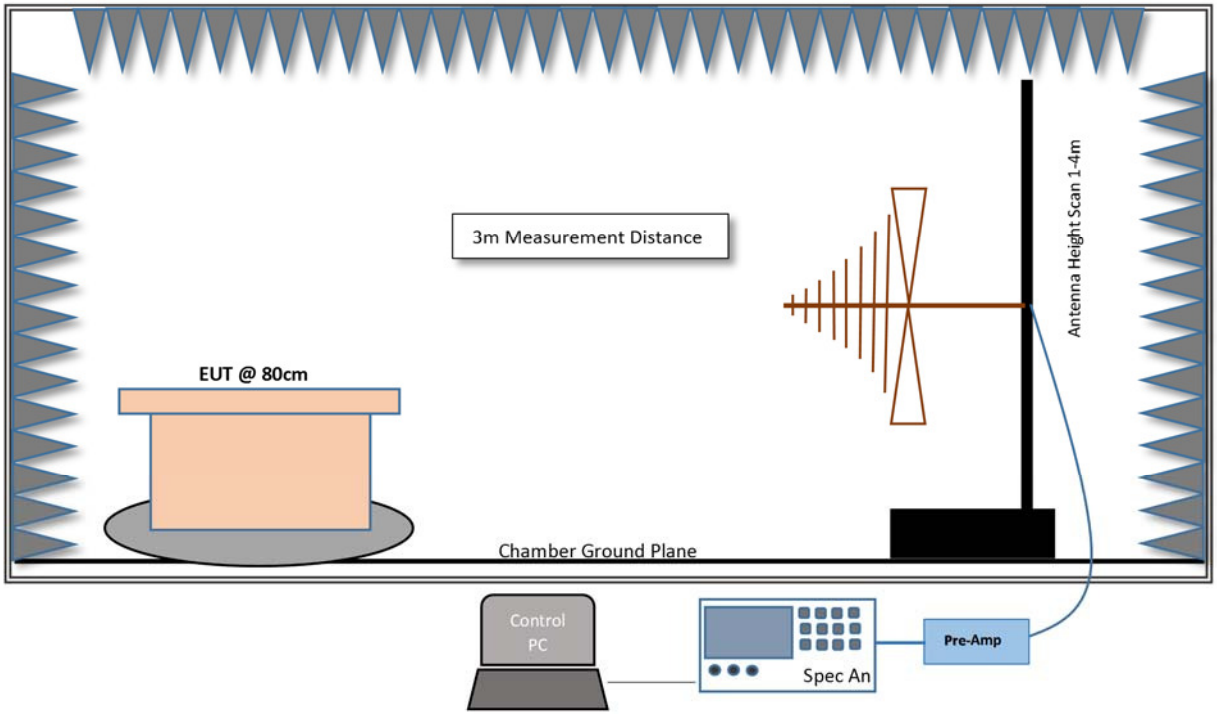


Fig.2. Test Setup for Radiated measurements in 30MHz- 1GHz Range

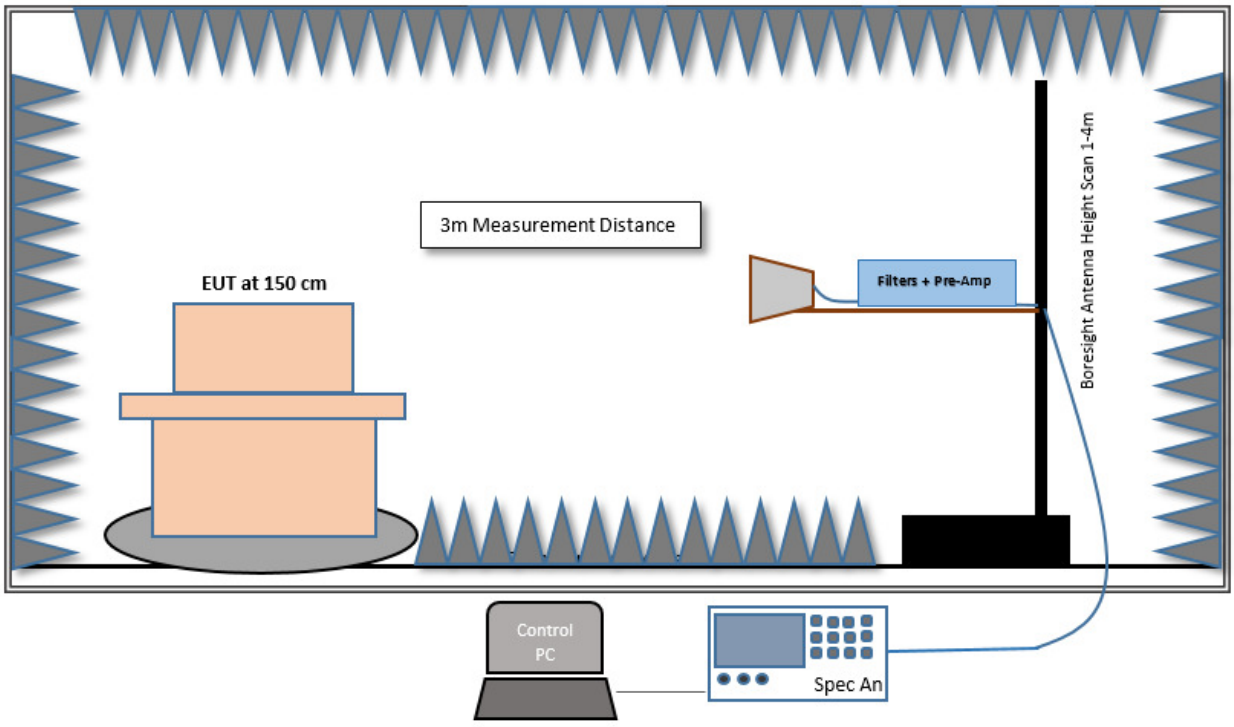


Fig.3. Test Setup for Radiated measurements in 1GHz- 18GHz Range

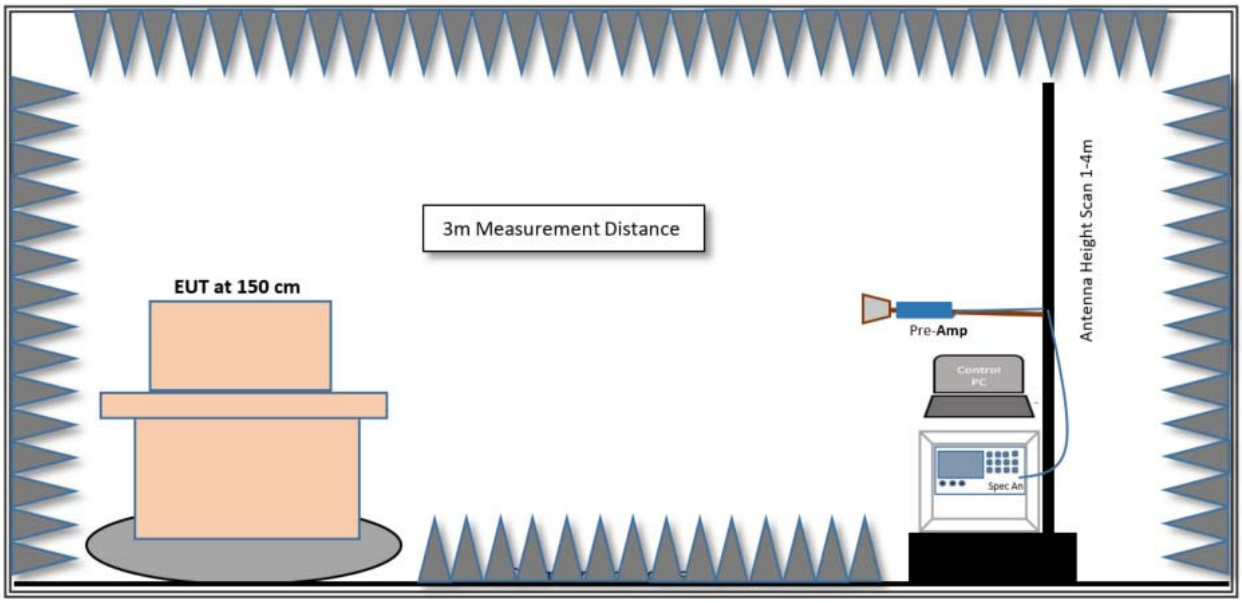


Fig.4. Test Setup for Radiated measurements >18GHz

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 ≥ Occupied Bandwidth if possible; otherwise, set RBW to the largest available value
VBW ≥ RBW ≥ Signal Period
Detector = Peak
Span = 0 Hz
Sweep points > 100

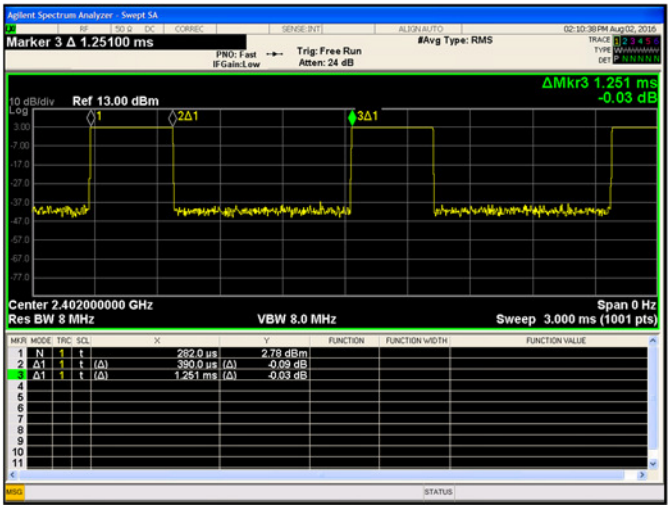
9.1.3 Limits:

Reporting and measurement purposes only.

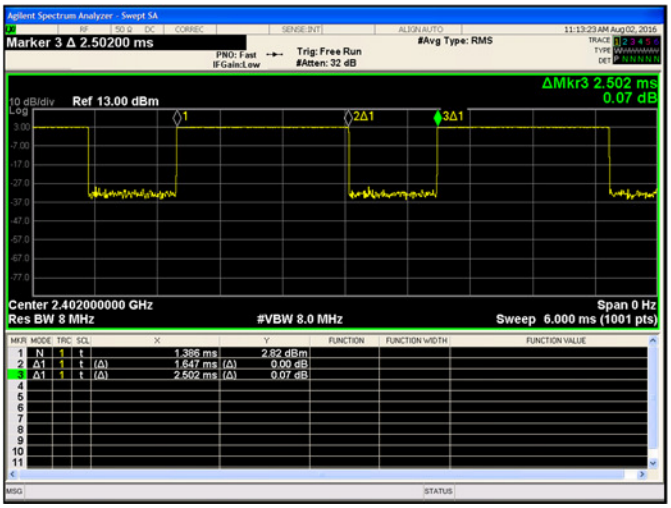
9.1.4 Test Results:

Frequency	Data Rate	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
2402	1-DH1	0.39	1.25	31.20	5.06
2402	1-DH3	1.65	2.50	65.80	1.82
2402	1-DH5	2.90	3.75	77.20	1.12

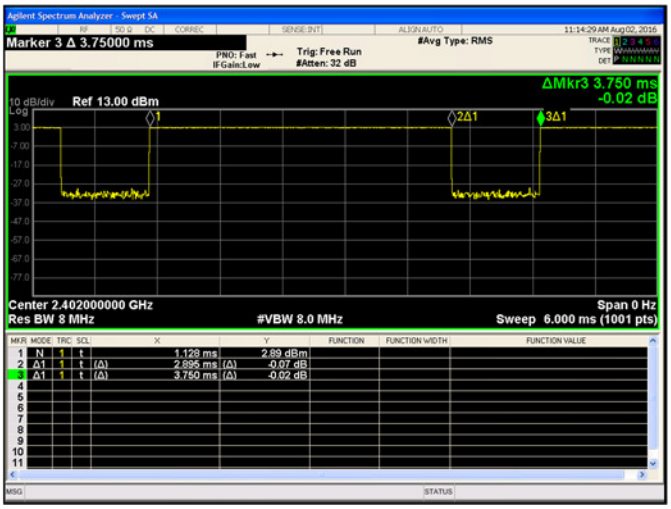
9.1.5 Test Data:



Plot 9-1. Duty Cycle (Ch. 0, 1-DH1)



Plot 9-2. Duty Cycle (Ch. 0, 1-DH3)



Plot 9-3. Duty Cycle (Ch. 0, 1-DH5)

9.2 20dB and 99% Occupied Bandwidth

9.2.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (a)(1)(iii)

ISED RSS-247 [5.1]

9.2.2 Test Method:

Measurements were performed according to the procedure defined in DA 00-705 'Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems' and ANSI C63.10:2013.

Spectrum analyzer settings:
The x dB (-20dB) function on the spectrum analyzer was used to measure 20dB BW with the settings below:
Span = approximately 2 to 3 times the 20 dB/99% Occupied bandwidth, centered on a hopping channel
RBW ≥ 1 to 5 % of the 20 dB bandwidth
VBW ≥ 3x RBW
Sweep = Auto
Detector function = Peak
Trace = Max Hold
The internal function of the spectrum analyzer is used to measure the 99% bandwidth.

9.2.3 Limits:

N/A- Reporting Purposes only.

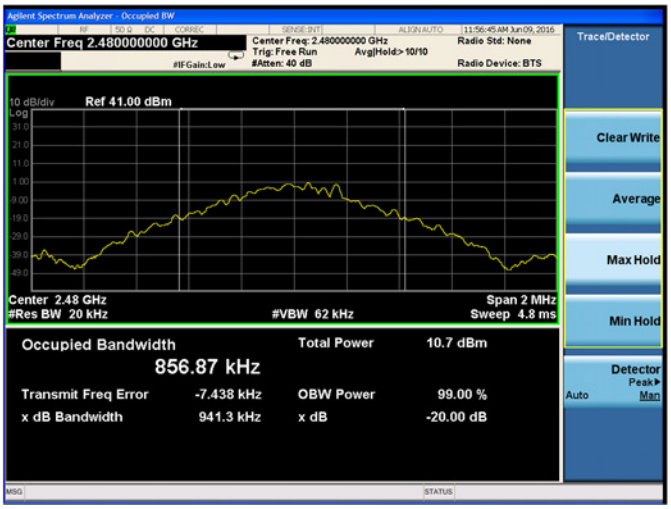
9.2.4 Test Results:

Frequency (MHz)	Mode	Data Rate (Mbps)	Channel No.	20 dB Bandwidth (kHz)	99% Occupied Bandwidth (kHz)
2402	1-DH5	1	0	940.9	857.3
2441	1-DH5	1	39	942.5	862.0
2480	1-DH5	1	78	941.3	856.9
2402	2-DH5	2	0	1322.0	1172.1
2441	2-DH5	2	39	1322.0	1172.1
2480	2-DH5	2	78	1323.0	1172.2
2402	3-DH5	3	0	1309.0	1176.8
2441	3-DH5	3	39	1310.0	1176.5
2480	3-DH5	3	78	1310.0	1176.1

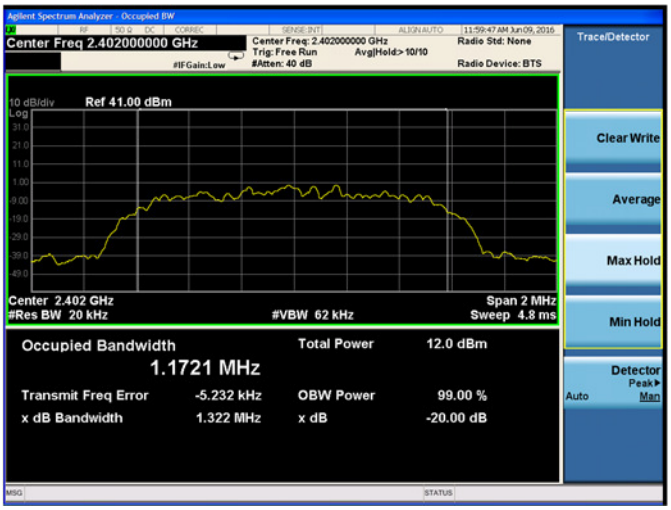
9.2.5 Test Data:

Plot 9-4. 20dB Bandwidth (Ch. 0, 1-DH5)

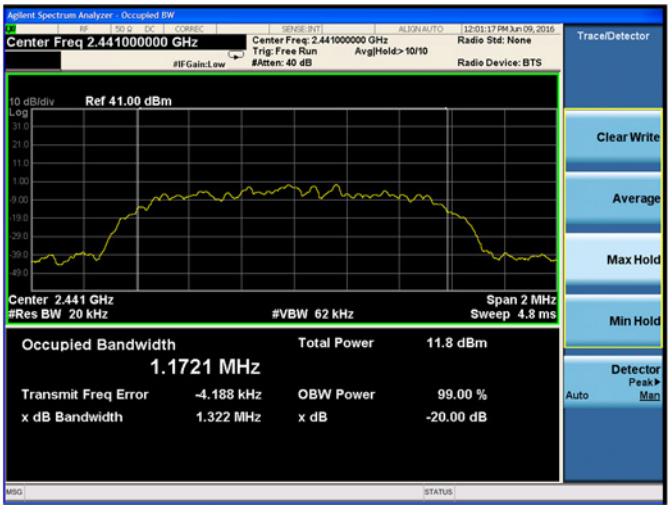
Plot 9-5. 20dB Bandwidth (Ch. 39, 1-DH5)



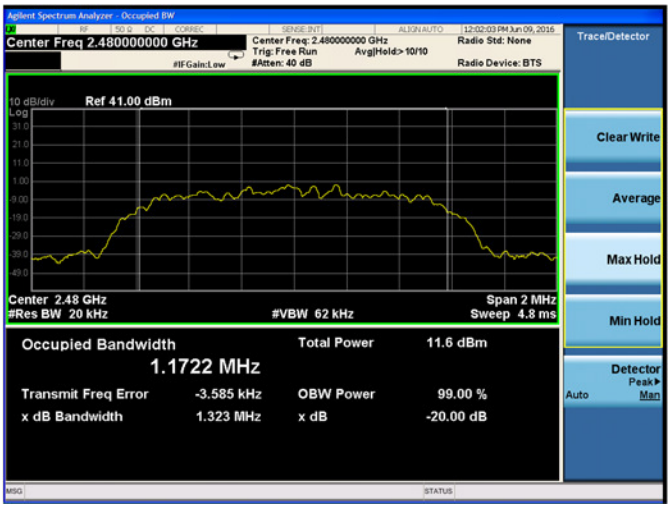
Plot 9-6. 20dB Bandwidth (Ch. 78, 1-DH5)



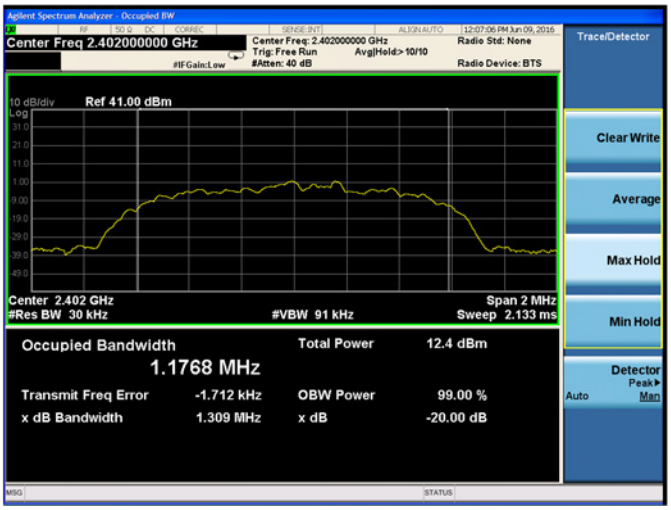
Plot 9-7. 20dB Bandwidth (Ch. 0, 2-DH5)



Plot 9-8. 20dB Bandwidth (Ch. 39, 2-DH5)



Plot 9-9. 20dB Bandwidth (Ch. 78, 2-DH5)



Plot 9-10. 20dB Bandwidth (Ch. 0, 3-DH5)

Plot 9-11. 20dB Bandwidth (Ch. 39, 3-DH5)

Plot 9-12. 20dB Bandwidth (Ch. 78, 3-DH5)

9.3 Output Power

9.3.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (b)(1)

ISED RSS-247 [5.4]

9.3.2 Test Method:

Measurements were performed according to the procedure defined in DA 00-705 'Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems' and ANSI C63.10:2013.

Spectrum analyzer settings:

Peak Power Measurements:
Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel= 5 MHz
RBW > the 20 dB bandwidth of the emission being measured= 1.5 MHz
VBW ≥ 3 x RBW= 5 MHz
Sweep = Auto
Detector function = Peak
Trace = Max Hold
The trace was allowed to stabilize. A Marker was set to the peak of the emission. The indicated level is the peak output power.

9.3.3 Limits:

15.247: 1 Watt (30dBm) if ≥ 75 non-overlapping channels. Additionally, for EDR modes, 21dBm.

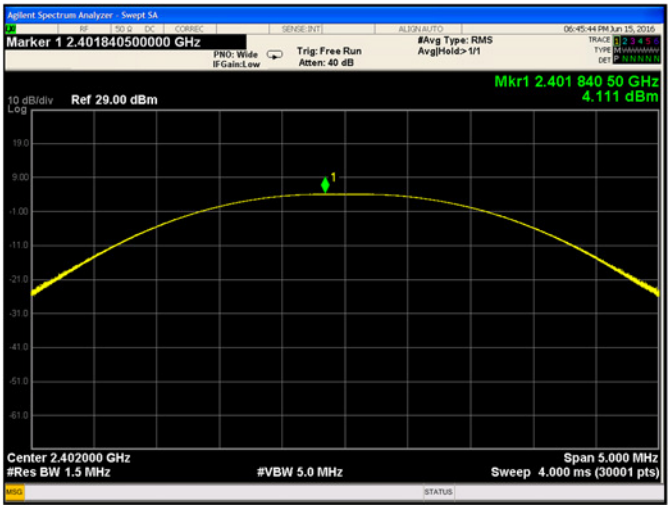
RSS-247: 1 W (30dBm) conducted and 4 W (36dBm) EIRP.

9.3.4 Test Results:

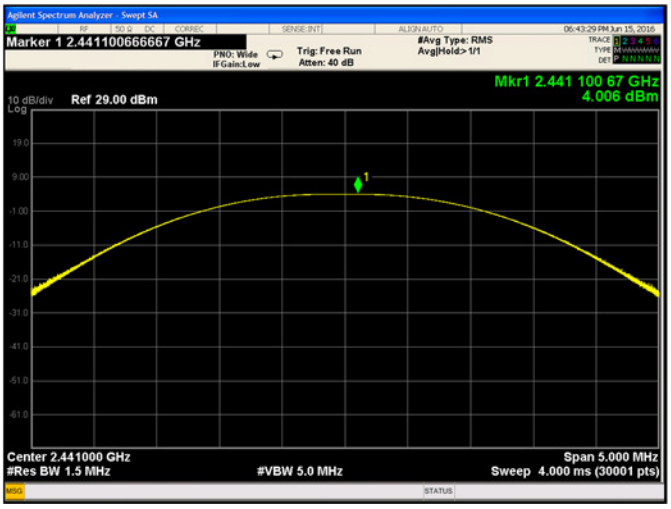
Frequency (MHz)	Mode	Data Rate (Mbps)	Channel No.	Cond. Peak Power (dBm)	FCC Limit (dBm)	Margin (dBm)	Results
2402	1-DH5	1	0	4.11	30	-25.89	Pass
2441	1-DH5	1	39	4.01	30	-25.99	Pass
2480	1-DH5	1	78	3.90	30	-26.10	Pass
2402	2-DH5	2	0	6.93	21	-14.07	Pass
2441	2-DH5	2	39	6.74	21	-14.26	Pass
2480	2-DH5	2	78	6.55	21	-14.45	Pass
2402	3-DH5	3	0	7.25	21	-13.75	Pass
2441	3-DH5	3	39	7.06	21	-13.94	Pass
2480	3-DH5	3	78	6.84	21	-14.16	Pass

Frequency (MHz)	Mode	Data Rate (Mbps)	Channel No.	Cond. Peak Power (dBm)	Max Antenna Gain (dBi)	EIRP (dBm)	ISED Limit (dBm)	Margin (dBm)	Results
2402	1-DH5	1	0	4.11	1.01	5.12	36	-30.88	Pass
2441	1-DH5	1	39	4.01	1.01	5.02	36	-30.98	Pass
2480	1-DH5	1	78	3.90	1.01	4.91	36	-31.09	Pass
2402	2-DH5	2	0	6.93	1.01	7.94	27	-19.06	Pass
2441	2-DH5	2	39	6.74	1.01	7.75	27	-19.25	Pass
2480	2-DH5	2	78	6.55	1.01	7.56	27	-19.44	Pass
2402	3-DH5	3	0	7.25	1.01	8.26	27	-18.74	Pass
2441	3-DH5	3	39	7.06	1.01	8.07	27	-18.93	Pass
2480	3-DH5	3	78	6.84	1.01	7.85	27	-19.15	Pass

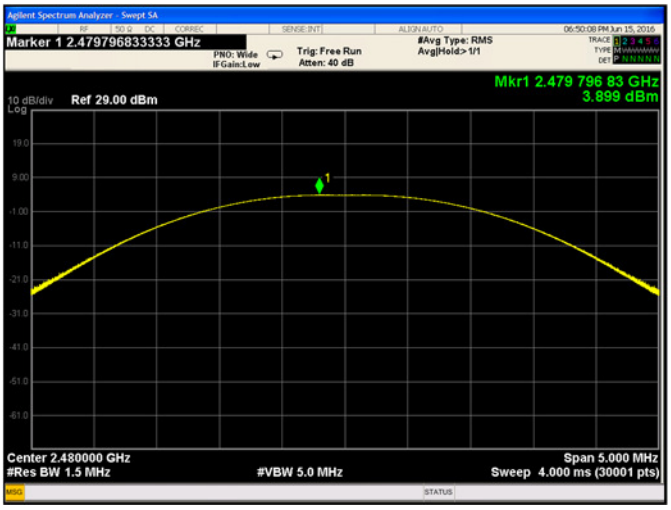
9.3.5 Test Data:



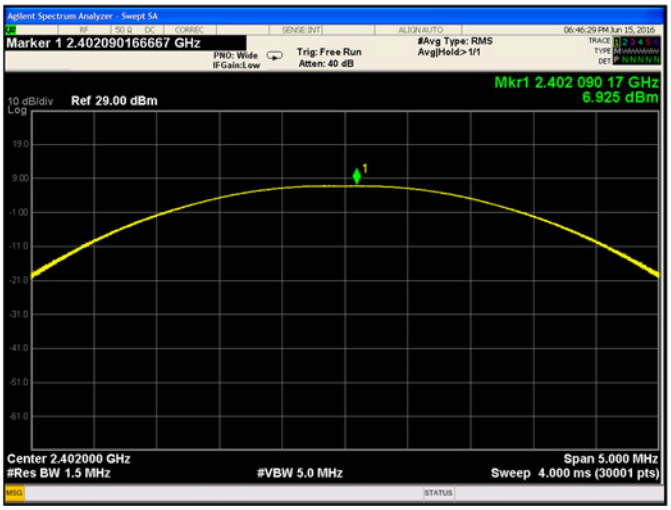
Plot 9-13. Peak Power (Ch. 0, 1-DH5)



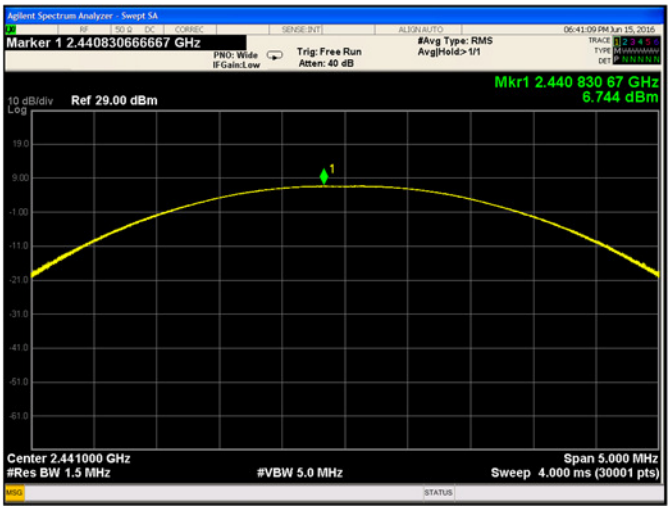
Plot 9-14. Peak Power (Ch. 39, 1-DH5)



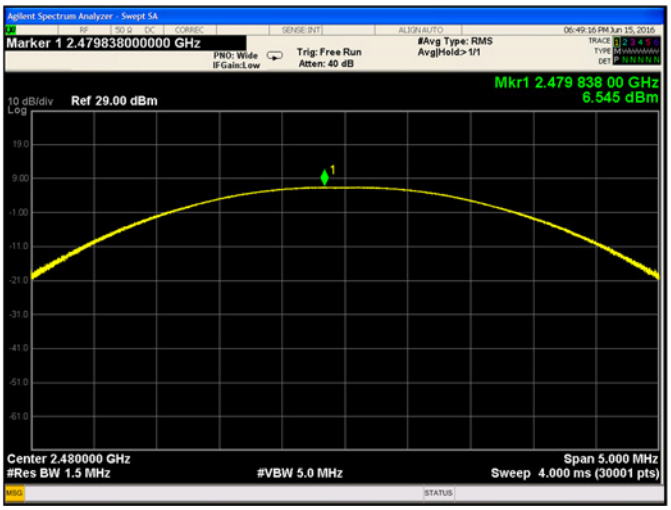
Plot 9-15. Peak Power (Ch. 78, 1-DH5)



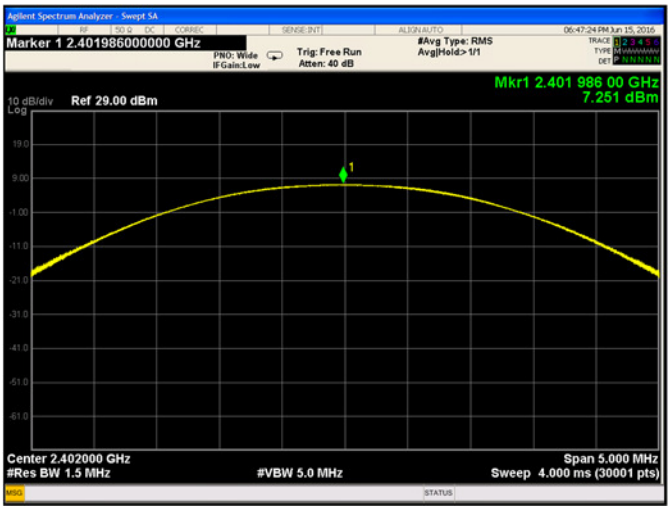
Plot 9-16. Peak Power (Ch. 0, 2-DH5)



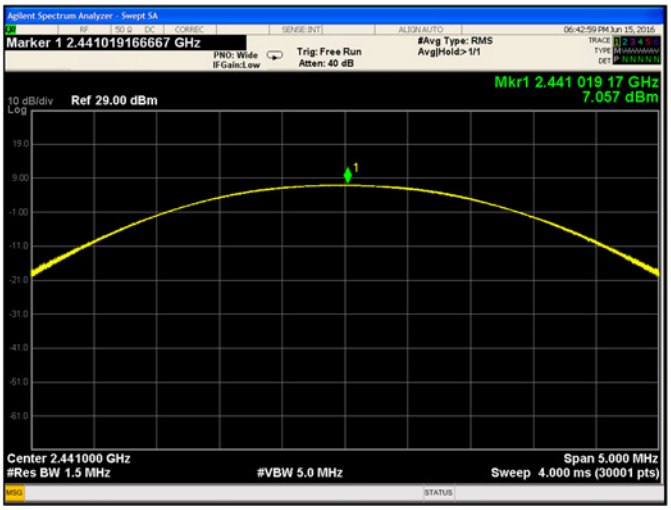
Plot 9-17. Peak Power (Ch. 39, 2-DH5)



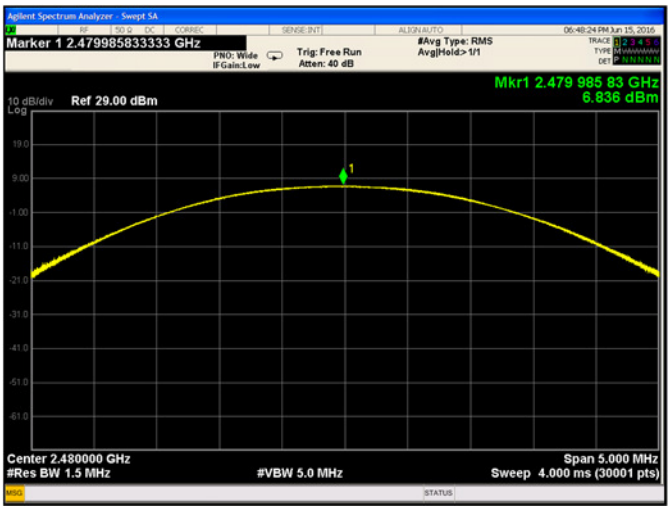
Plot 9-18. Peak Power (Ch. 78, 2-DH5)



Plot 9-19. Peak Power (Ch. 0, 3-DH5)



Plot 9-20. Peak Power (Ch. 39, 3-DH5)



Plot 9-21. Peak Power (Ch. 78, 3-DH5)

9.4 Channel Spacing

9.4.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (a)(1)

ISED RSS-247 [5.1]

9.4.2 Test Method:

Measurements were performed according to the procedure defined in DA 00-705 'Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems' and ANSI C63.10:2013. The EUT was in pseudorandom hopping mode with the separation of two peaks measured using the delta marker.

Spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) = 300 kHz
Video (or Average) Bandwidth (VBW) ≥ RBW= 910 kHz
Sweep = Auto
Detector function = Peak
Trace = Max Hold
The trace(s) was allowed to stabilize. The marker-delta function was used to determine the separation between the peaks of the adjacent channels.

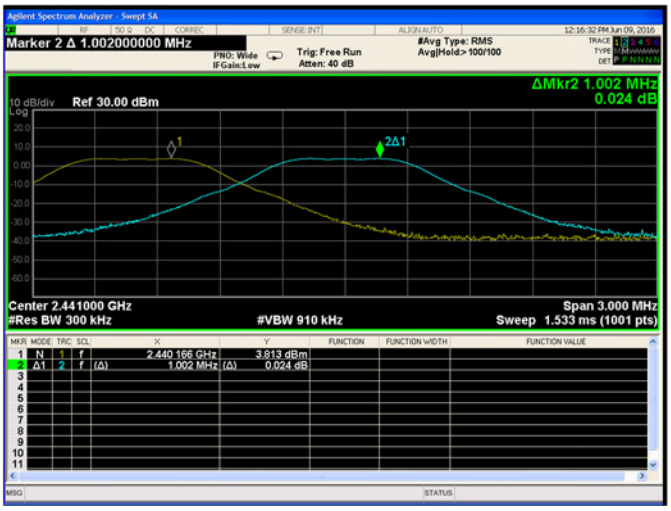
9.4.3 Limits:

The channel carrier frequencies must be separated by 25kHz or the 20dB BW of the hopping channel whichever is greater. If the output power is less than 125mW, then the channel separation can be 2/3 of the 20dB bandwidth 623.33kHz or 25kHz whichever is greater.

9.4.4 Test Results:

Pass.
Minimum channel separation= 1.002 MHz in 1-DH5 Mode.

9.4.5 Test Data:



Plot 9-22 Channel Separation

9.5 Number of Hopping Frequencies

9.5.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (a)(1)(iii)

ISED RSS-247 [5.1]

9.5.2 Test Method:

Measurements were performed according to the procedure defined in DA 00-705 'Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems' and ANSI C63.10:2013. The EUT had its hopping function enabled.

Spectrum analyzer settings:

Span = the frequency band of operation
RBW < 30% of the OBW= 300 kHz
VBW ≥ RBW = 3 MHz
Sweep = Auto
Detector function = Peak
Trace = Max Hold
The trace was allowed to stabilize and the number of channels was counted.

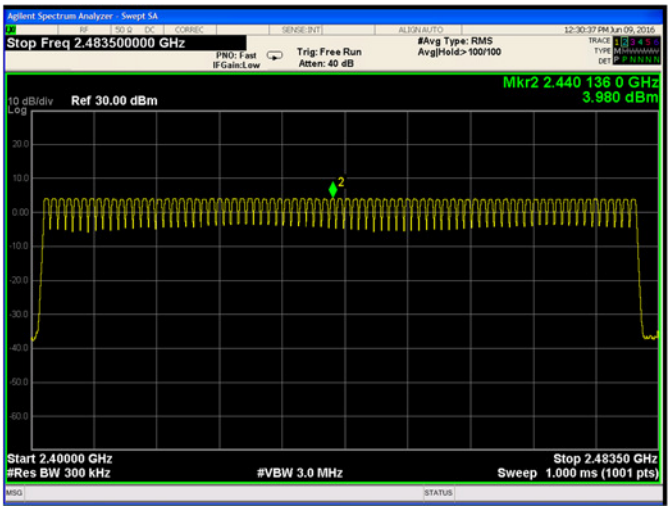
9.5.3 Limits:

The minimum number of hopping channels required is 15.

9.5.4 Test Results

Pass.
The EUT utilizes 79 hopping channels in BDR and EDR modes. In AFH mode, the EUT utilizes a minimum of 20 hopping channels.

9.5.5 Test Data:



Plot 9-23. Number of Hopping Channels

9.6 Dwell Time

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (a)(1)(iii)

ISED RSS-247 [5.1]

9.6.2 Test Method:

Measurements were performed according to the procedure defined in DA 00-705 'Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems' and ANSI C63.10:2013. The EUT had its hopping function enabled.

Spectrum analyzer settings:
Span = zero span, centered on a hopping channel
RBW = 100 kHz
VBW ≥ 3 x RBW= 300 kHz
Sweep = as necessary to capture the entire dwell time per hopping channel = 4ms
Detector function = Peak
Trace = Clear Write/ Trigger Mode

Dwell Time is measured with analyzer set to zero span at the middle channel and the trigger set to capture a burst.

9.6.3 Limits:

400 ms

9.6.4 Test Results:

Pass.

Standard Bluetooth 1x/EDR has a channel hopping rate of 1600 hops/s.

1x/EDR mode uses 5 transmit and 1 receive slots for a total of 6 slots.

Bluetooth is hopping at a rate of 1600/6 = 266.67 hops/s/slot. Then, 266.67 hops/s/79 channels = 3.38 hops/s for one channel.

The dwell time limit is number of hopping channels * 400ms. For Bluetooth, 79 channels *400ms = 31.6 s.

So the number of hops over a 31.6 s period is 3.38 hops/s * 31.6 s = 106.67 hops.

Worst case dwell time for one channel in DH5 mode = 106.67 hops * Dwell Time = 106.67 hops * 2.870ms = 306.14 ms.

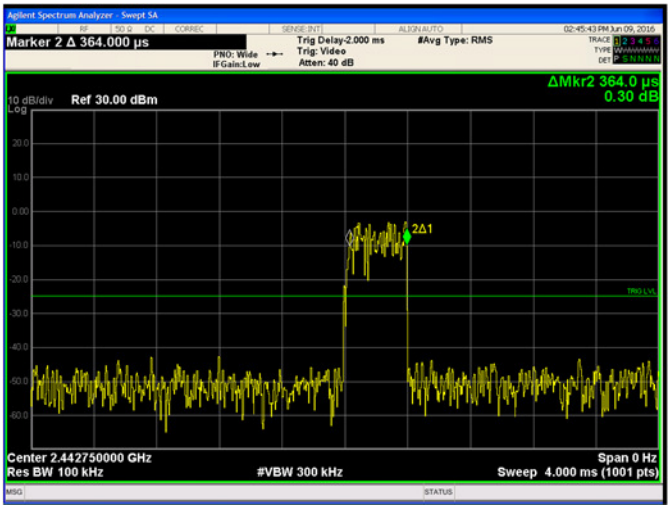
In AFH mode, the EUT utilizes a minimum of 20 channels. In this mode, the hopping rate is reduced to 800 hops/s with 6 time slots.

The hopping rate is calculated as 800/6 = 133.33 hops/s/slot. Since there are a minimum of 20 channels, 133.33 hops/s/slot/20 channels = 6.67 hops/s on a single channel.

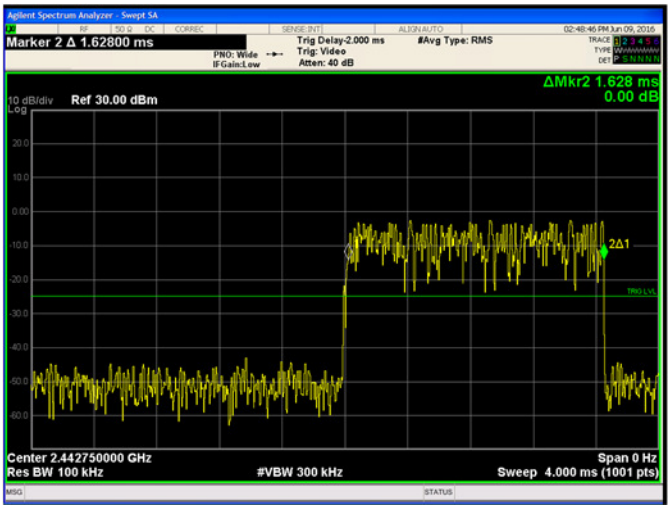
The number of hops over an 8 s period is 6.67 hops/s * 8 s = 53.36 hops.

The worst case dwell time for one channel = 53.36 hops * Dwell Time = 53.6 hops * 2.870 ms = 153.83 ms.

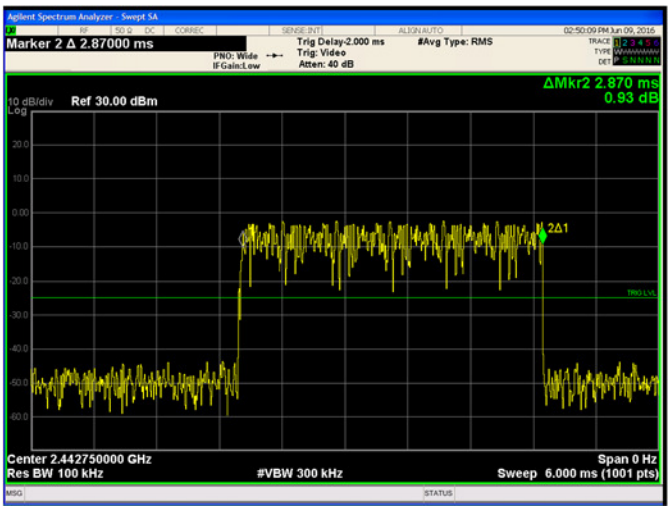
9.6.5 Test Data:



Plot 9-24. Dwell Time – DH1



Plot 9-25. Dwell Time – DH3



Plot 9-26 Dwell Time - DH5

9.7 Band Edge

9.7.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.7.2 Test Method:

Measurements were performed according to the procedure defined in DA 00-705 'Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems' and ANSI C63.10:2013.

Spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
RBW = 100 kHz
VBW = 300 kHz
Sweep = Auto
Detector function = Peak
Trace = Max Hold
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.

With the same instrument settings, the hopping function of the EUT was enabled and the trace was allowed to stabilize. The same procedure listed above was used to determine if any spurious emissions caused by the hopping function complied with the specified limit.

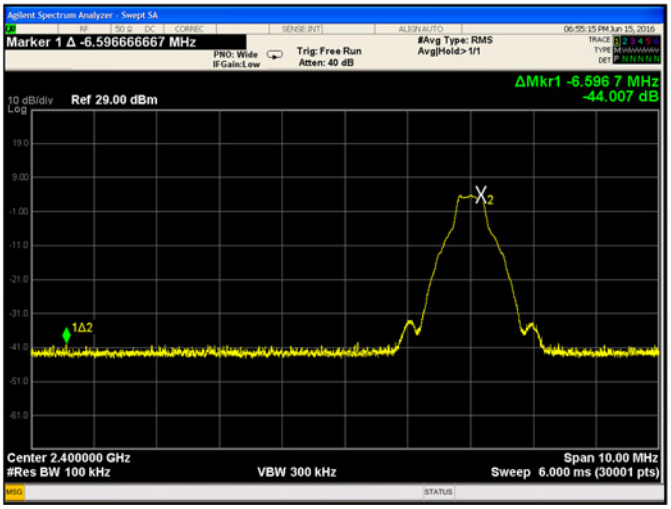
9.7.3 Limits:

The maximum level is at least 20dBc with measurements taken with the EUT in pseudorandom hopping mode and with hopping mode disabled.

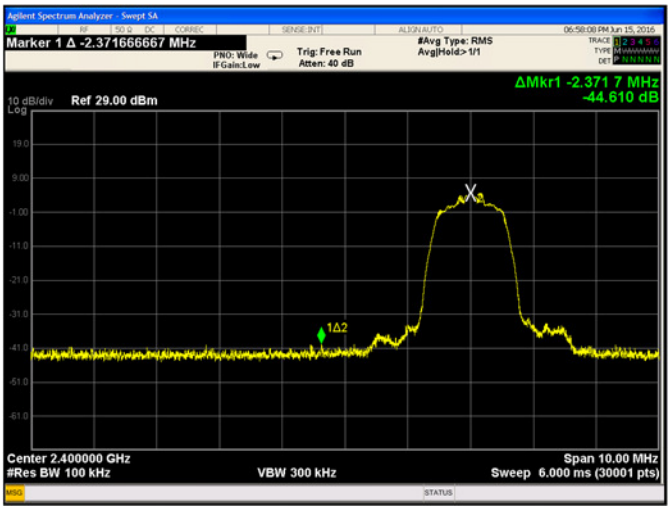
9.7.4 Test Results:

Pass.

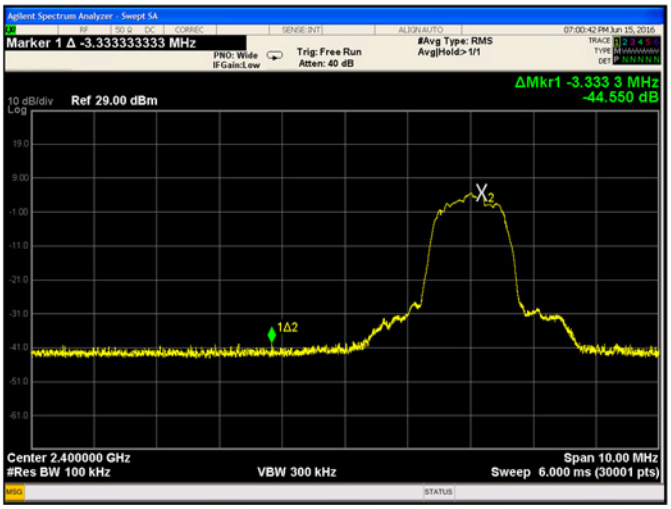
9.7.5 Test Data:



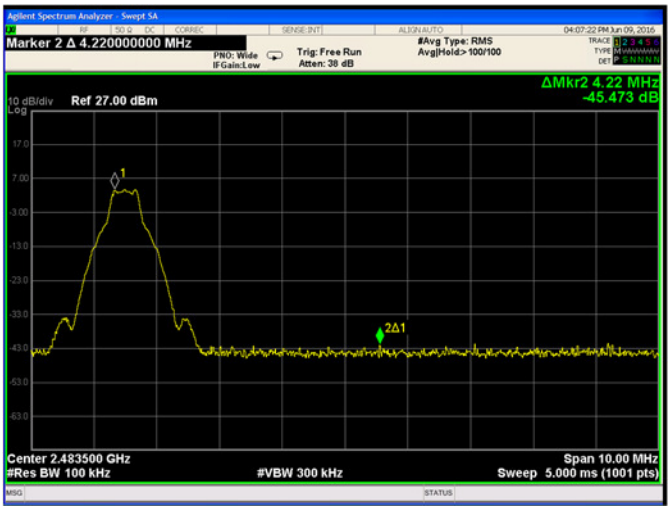
Plot 9-27. Low Channel Band edge: 1-DH5 Mode (Hopping disabled)



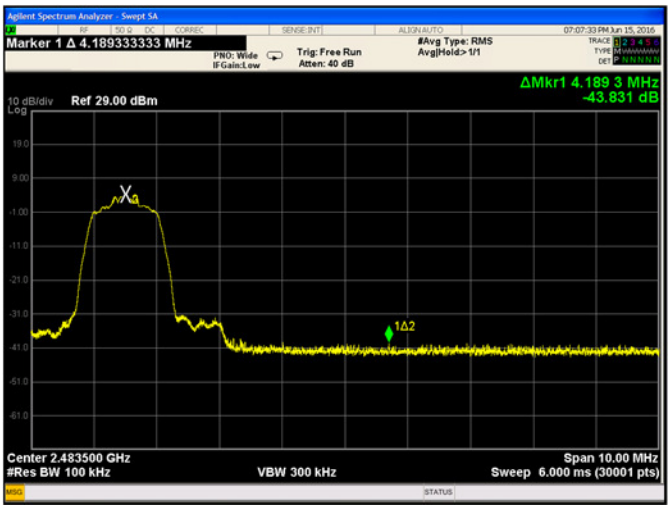
Plot 9-28. Low Channel Band edge: 2-DH5 Mode (Hopping disabled)



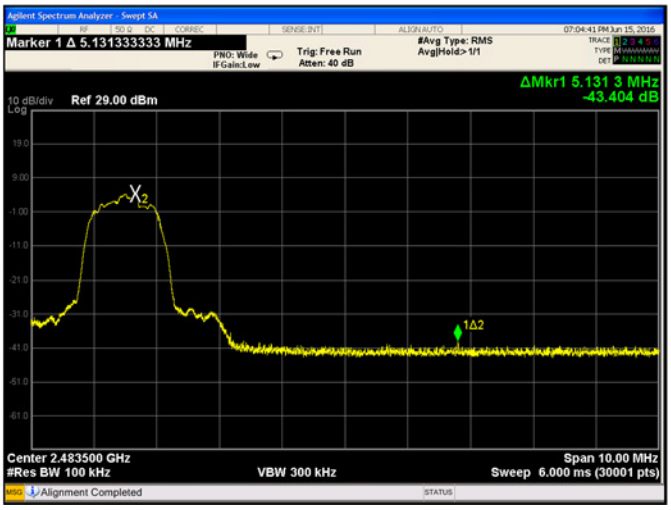
Plot 9-29. Low Channel Band edge: 3-DH5 Mode (Hopping disabled)



Plot 9-30. High Channel Band edge: 1-DH5 Mode (Hopping disabled)

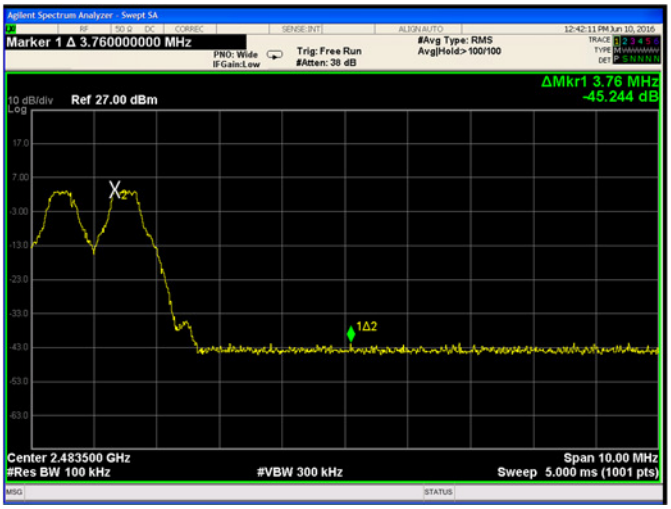


Plot 9-31. High Channel Band edge: 2-DH5 Mode (Hopping disabled)



Plot 9-32 High Channel Band edge: 3-DH5 Mode (Hopping disabled)

Plot 9-33. Low Channel Band edge (Hopping enabled)



Plot 9-34. High Channel Band edge (Hopping enabled)

9.8 Conducted Spurious Emissions

9.8.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.8.2 Test Method:

Measurements were performed according to the procedure defined in DA 00-705 'Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems' and ANSI C63.10:2013.

Spectrum analyzer settings:
Span = 30 M- 12 GHz; 12 G- 25 GHz
RBW = 1 MHz
VBW = 3 MHz
Sweep Time = Auto
Sweep Points= 30000
Detector function = Peak
Trace = Max Hold
If an emission is found within 3dB of the limit or exceeding the limit, reduce the RBW to 100 kHz for the final measurements.
The trace was allowed to stabilize. The marker was set on the peak of any spurious emission recorded. The level displayed had to comply with the limit specified.

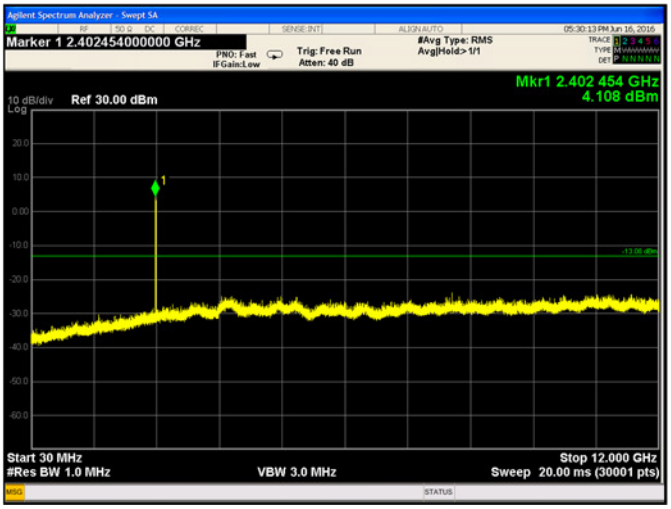
9.8.3 Limits:

The maximum spurious emission shall be at least 20dBc.

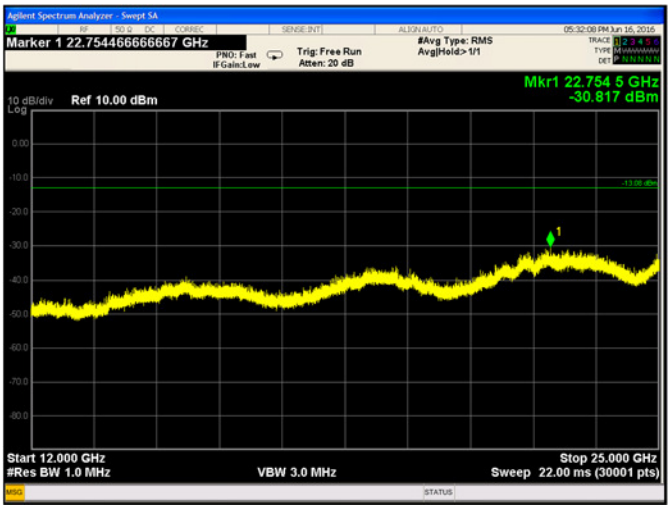
9.8.4 Test Results:

Pass

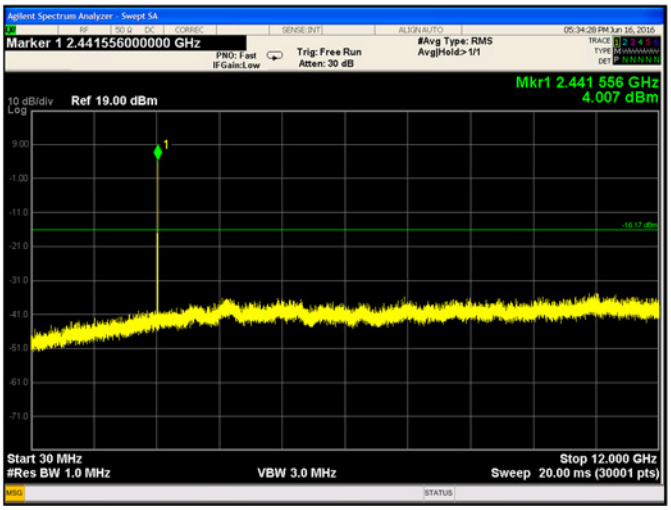
9.8.5 Test Data:



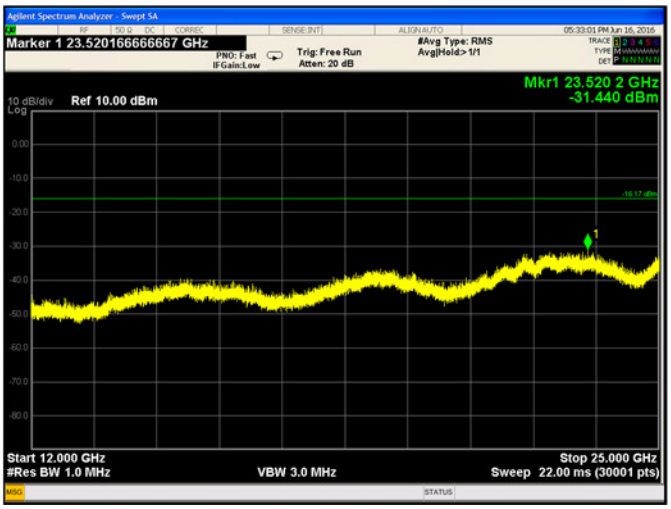
Plot 9-35. Conducted Spurious Emissions 30-12000 MHz: 1-DH5 Mode (Ch. 0)



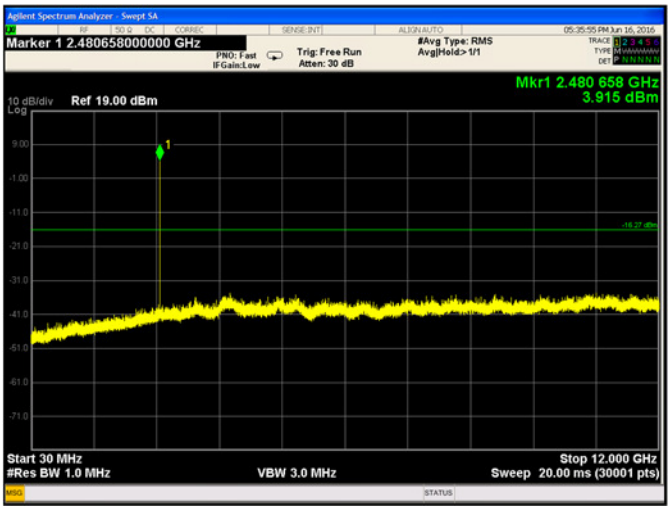
Plot 9-36. Conducted Spurious Emissions 12-25 GHz: 1-DH5 Mode (Ch. 0)



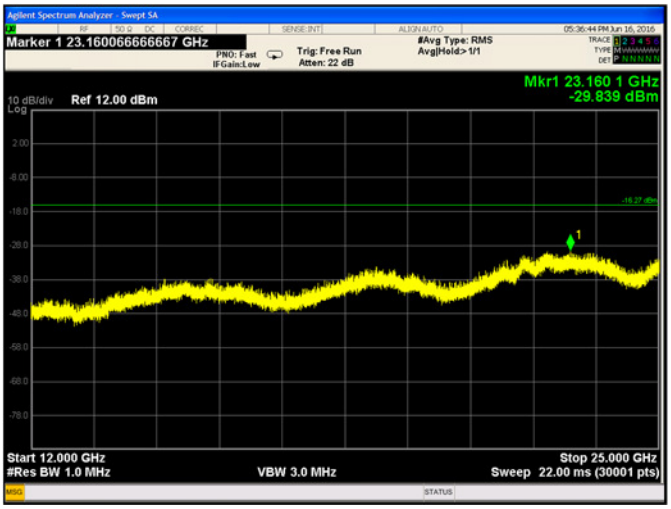
Plot 9-37. Conducted Spurious Emissions 30-12000 MHz: 1-DH5 Mode (Ch. 39)



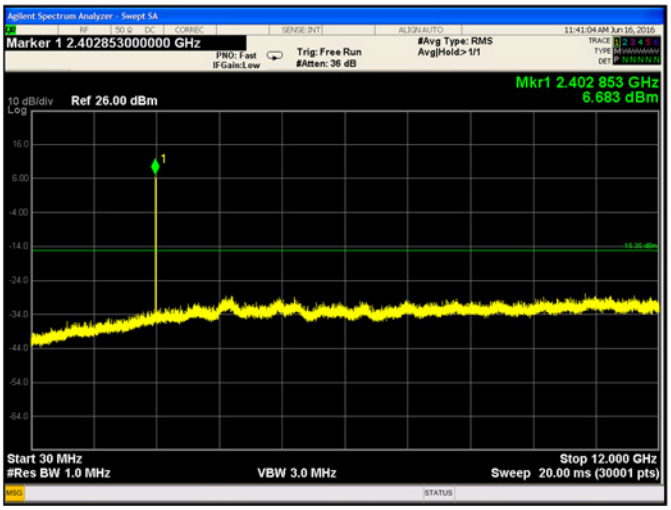
Plot 9-38. Conducted Spurious Emissions 12-25 GHz: 1-DH5 Mode (Ch. 39)



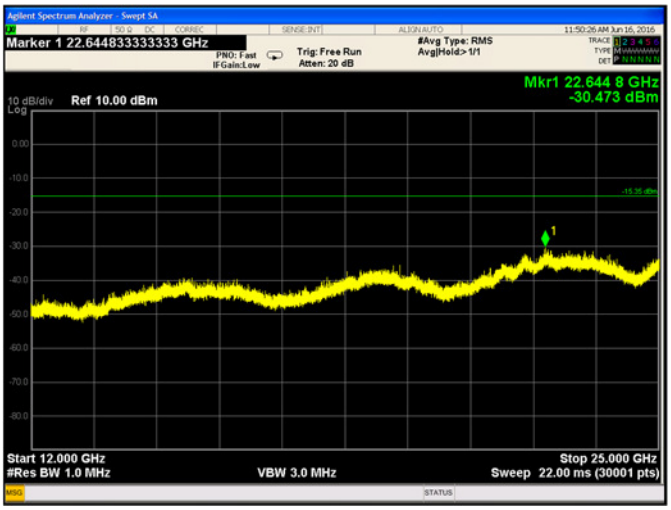
Plot 9-39. Conducted Spurious Emissions 30-12000 MHz: 1-DH5 Mode (Ch. 78)



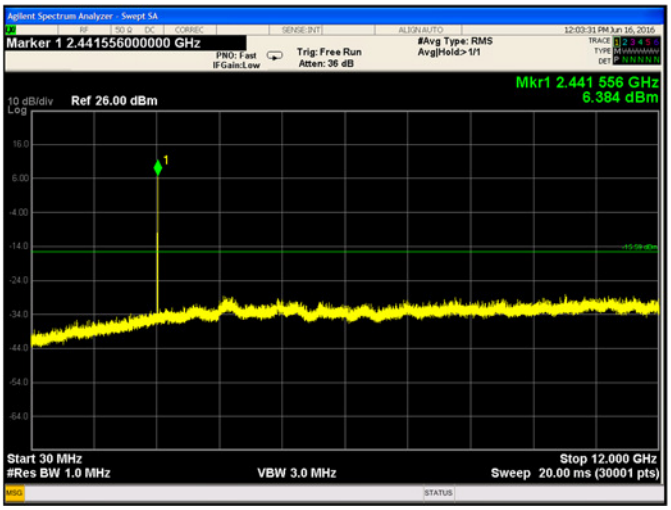
Plot 9-40. Conducted Spurious Emissions 12-25 GHz: 1-DH5 Mode (Ch. 78)



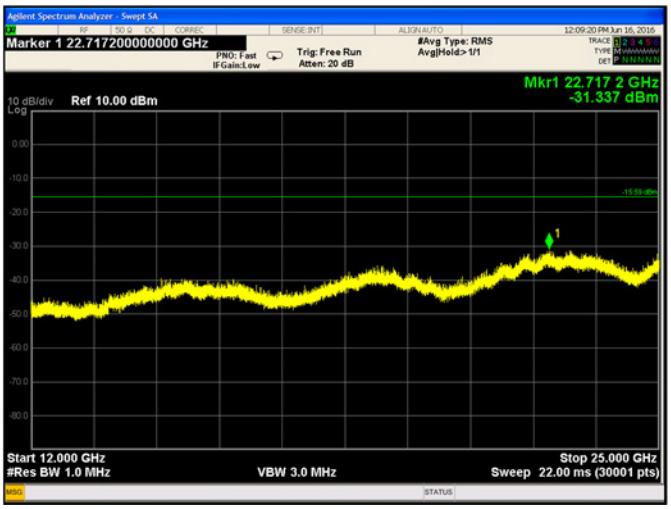
Plot 9-41. Conducted Spurious Emissions 30-12000 MHz: 2-DH5 Mode (Ch. 0)



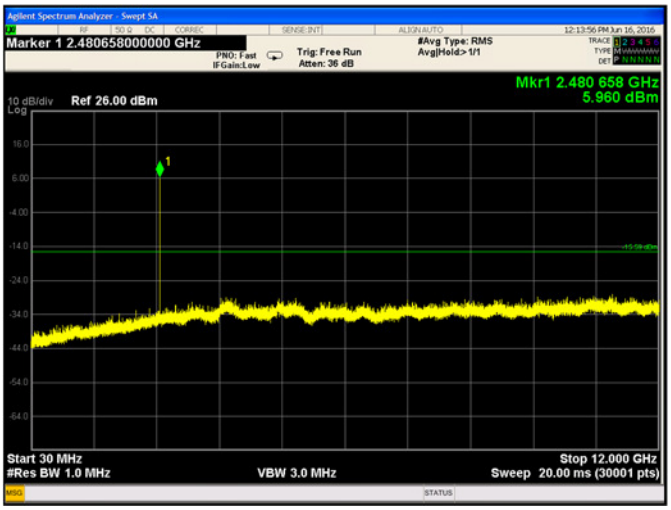
Plot 9-42. Conducted Spurious Emissions 12-25 GHz: 2-DH5 Mode (Ch. 0)



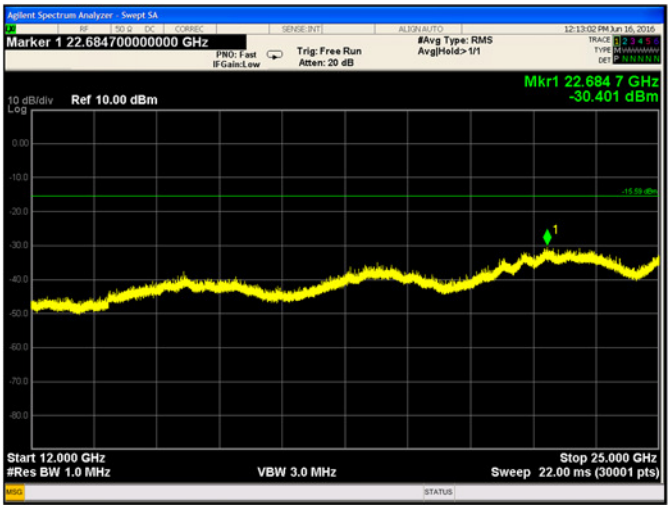
Plot 9-43. Conducted Spurious Emissions 30-12000 MHz: 2-DH5 Mode (Ch. 39)



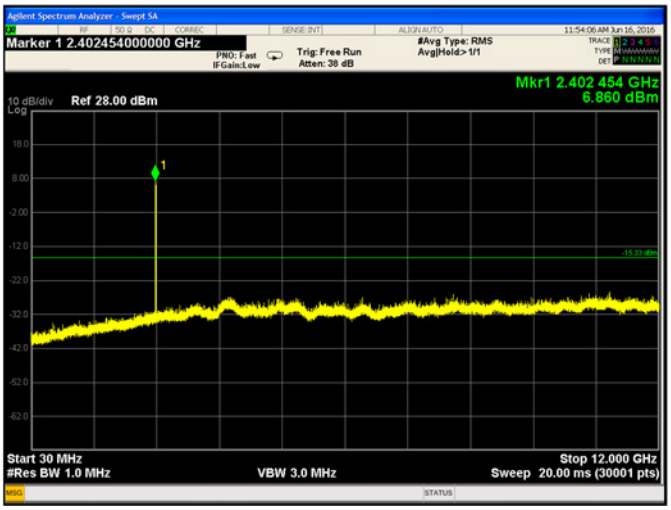
Plot 9-44. Conducted Spurious Emissions 12-25 GHz: 2-DH5 Mode (Ch. 39)



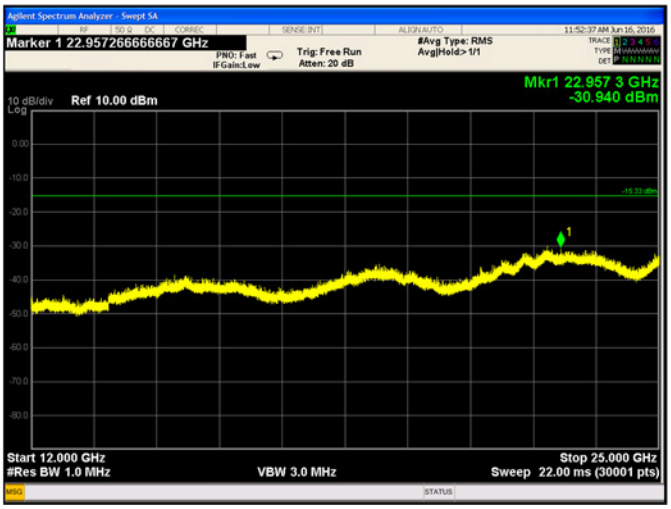
Plot 9-45. Conducted Spurious Emissions 30-12000 MHz: 2-DH5 Mode (Ch. 78)



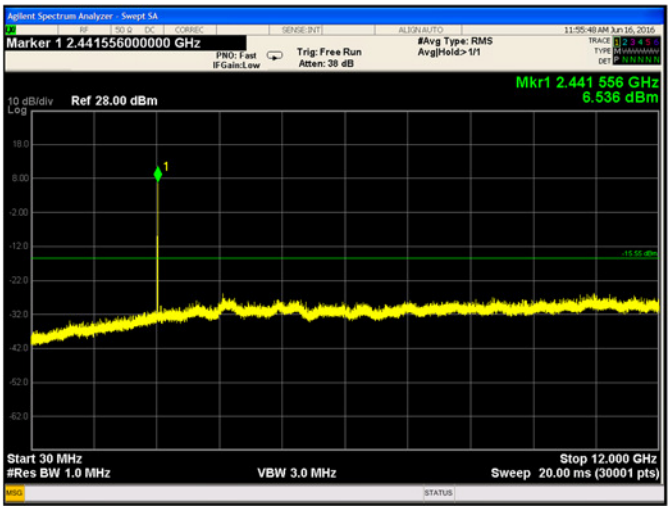
Plot 9-46. Conducted Spurious Emissions 12-25 GHz: 2-DH5 Mode (Ch. 78)



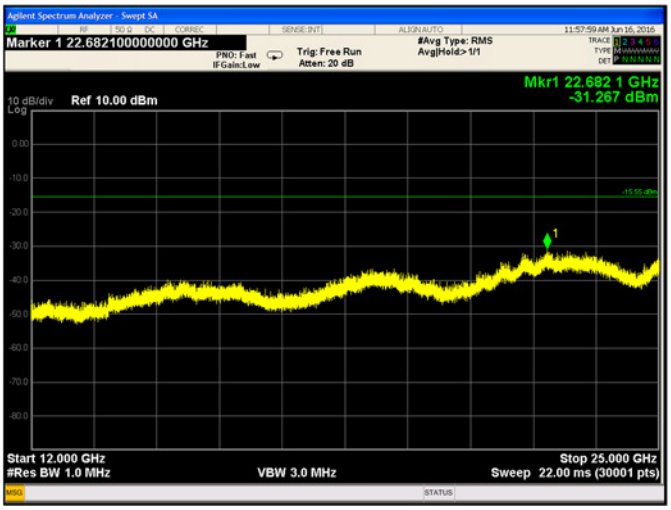
Plot 9-47. Conducted Spurious Emissions 30-12000 MHz: 3-DH5 Mode (Ch. 0)



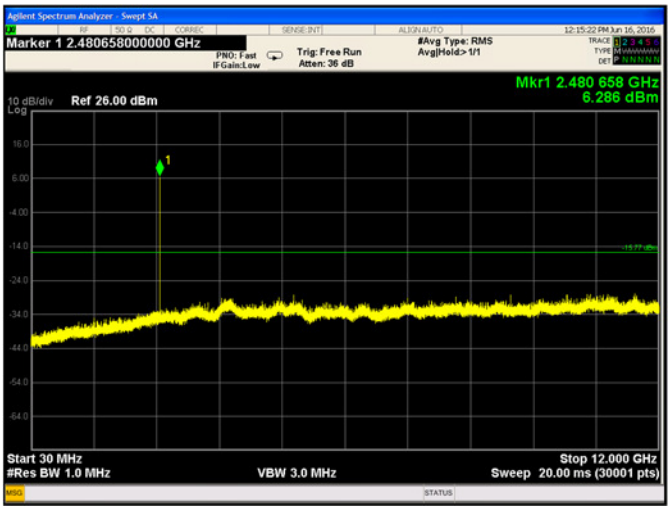
Plot 9-48. Conducted Spurious Emissions 12-25 GHz: 3-DH5 Mode (Ch. 0)



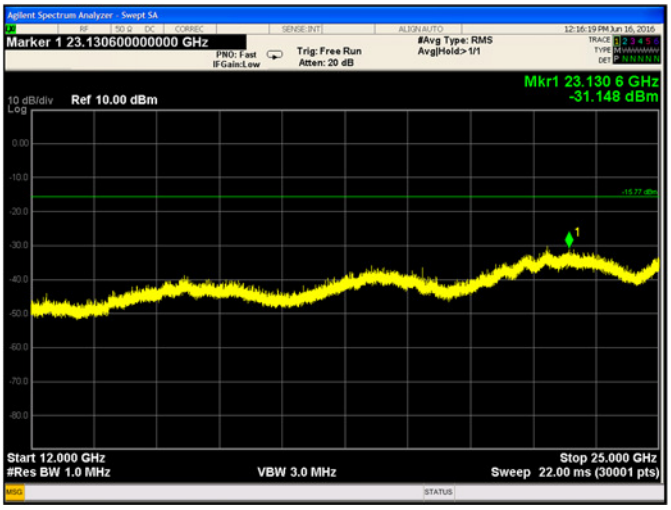
Plot 9-49. Conducted Spurious Emissions 30-12000 MHz: 3-DH5 Mode (Ch. 39)



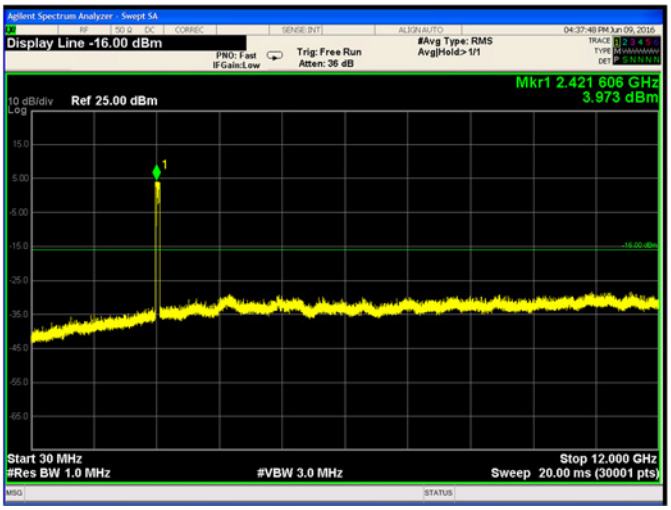
Plot 9-50. Conducted Spurious Emissions 12-25 GHz: 3-DH5 Mode (Ch. 39)



Plot 9-51. Conducted Spurious Emissions 30-12000 MHz: 3-DH5 Mode (Ch. 78)



Plot 9-52. Conducted Spurious Emissions 12-25 GHz: 3-DH5 Mode (Ch. 78)



Plot 9-53. Conducted Spurious Emissions 30-12000 MHz: 1-DH5 Mode (Hopping)

Plot 9-54. Conducted Spurious Emissions 12- 25 GHz: 1-DH5 Mode (Hopping)

9.9 Radiated Spurious and Band Edge Emissions

9.9.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5] and RSS GEN [8.9]

9.9.2 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.

Radiated spurious measurements are made from 30MHz to the 10th harmonic of the fundamental frequency of the transmitter. The limit for radiated spurious emissions is per 15.209 and RSS-247 [5.5]. 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 in each sub band. Guidelines in ANSI C63.10:2013 were followed with respect to maximizing the emissions. The EUT was placed on a turntable at a height of 80cm from the ground plane in standing position, which was estimated as the worst case orientation for all measurements.

Emissions below 1 GHz were maximized by rotating the EUT for 360 degs and with the antenna height scan performed from 1-4m. The same method was followed for emissions above 1GHz, but with the measurement antenna set in bore-sight mode. Both horizontal and vertical antenna polarizations were investigated. 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.

Radiated Spurious Emissions
Spectrum Analyzer Settings:
30 MHz- 1 GHz:
RBW= 120 kHz
VBW ≥ 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

Restricted Band-Edge Emissions

Spectrum Analyzer Settings:
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

Sample Calculation:

Field Strength Level: Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) – Amplifier Gain = 50 dBuV + 33 dB – 25 dB = 78dBuV/m

9.9.3 Limits:

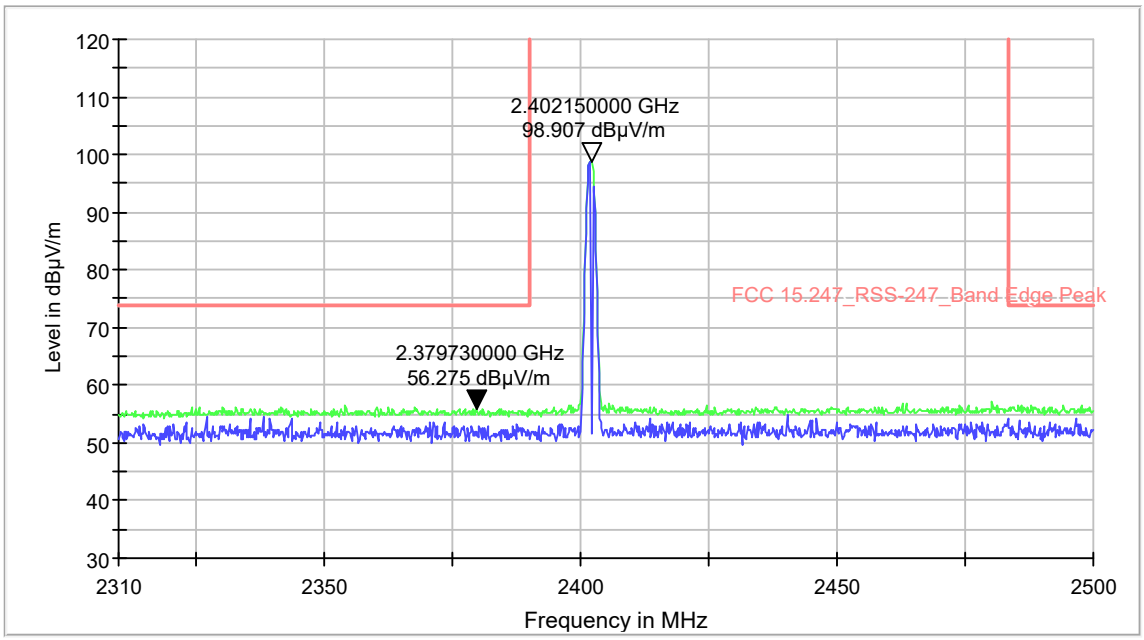
Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (meters)	Corrected Field Strength for 3m measurement distance (dBµV/m)
0.009-0.490	2400/F (kHz)	300	48.5- 13.8
0.490-1.705	24000/F (kHz)	30	33.8- 23.0
1.705-30	30	30	29.5
30-88	100	3	40
88-216	150	3	43.5
216-960	200	3	46
960-1000	500	3	54
Above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

9.9.4 Test Result:

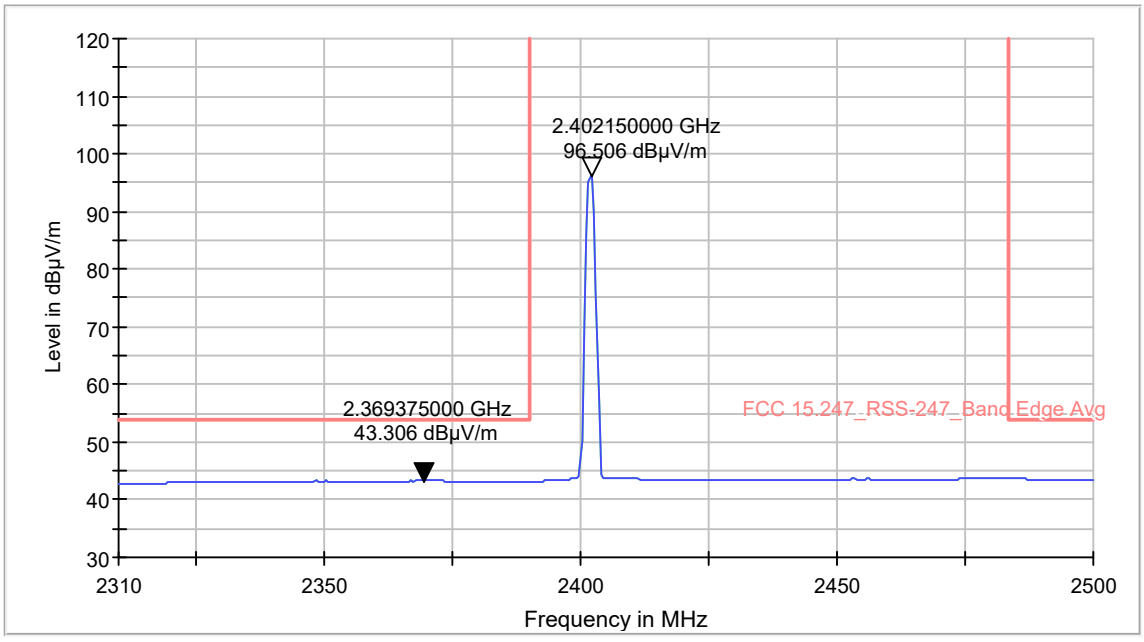
Pass.

9.9.5 Test Data:

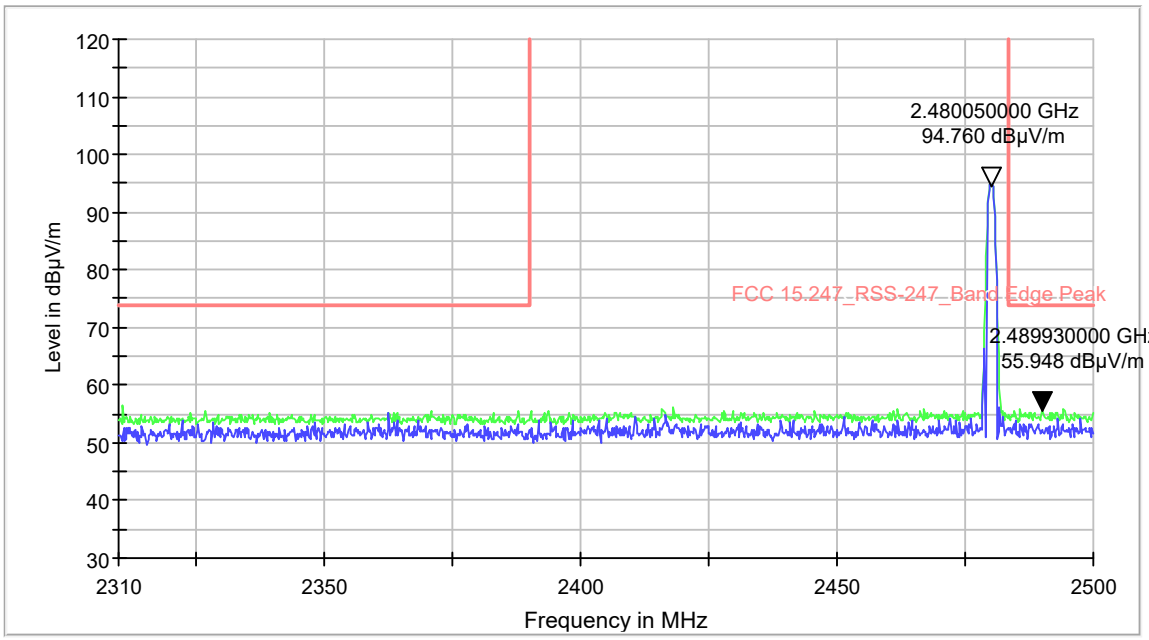
9.9.5.1 Radiated Restricted Band-edge emissions



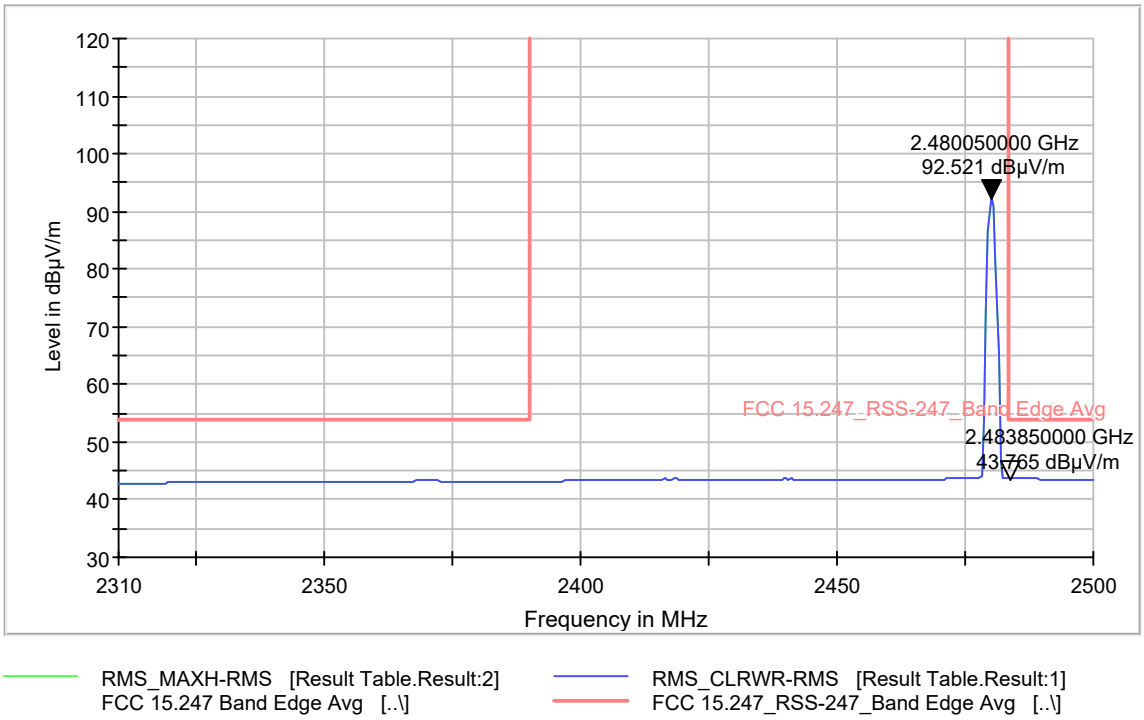
Plot 9-55. Restricted Band Edge 1-DH5 Mode– Ch. 0 (2310-2390MHz) – Peak



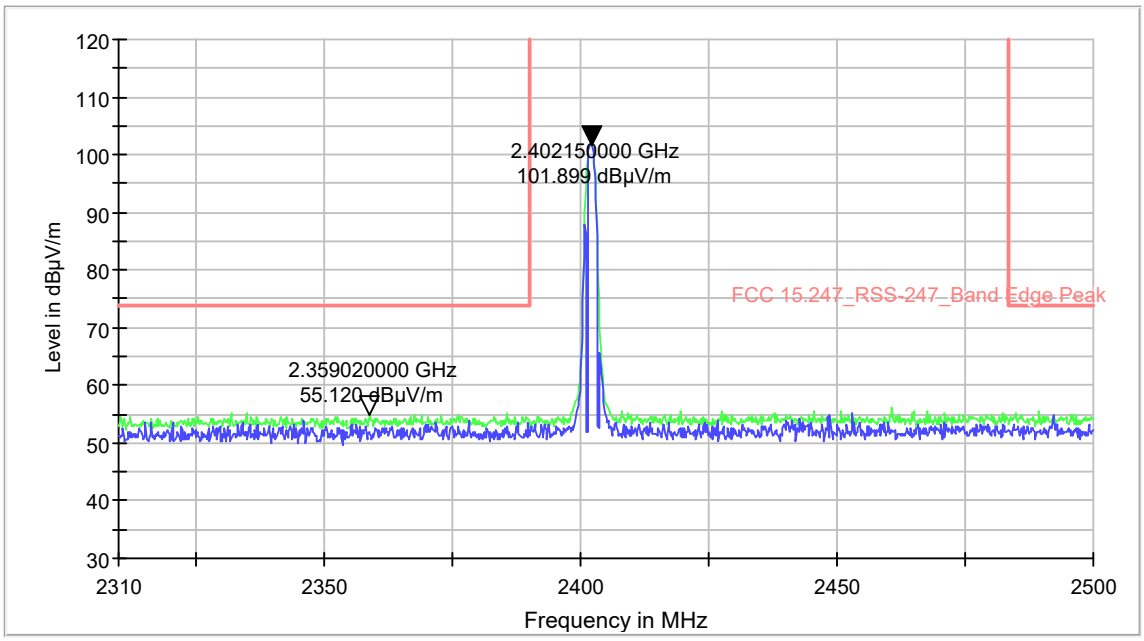
Plot 9-56. Restricted Band Edge 1-DH5 Mode– Ch. 0 (2310-2390MHz) – Average



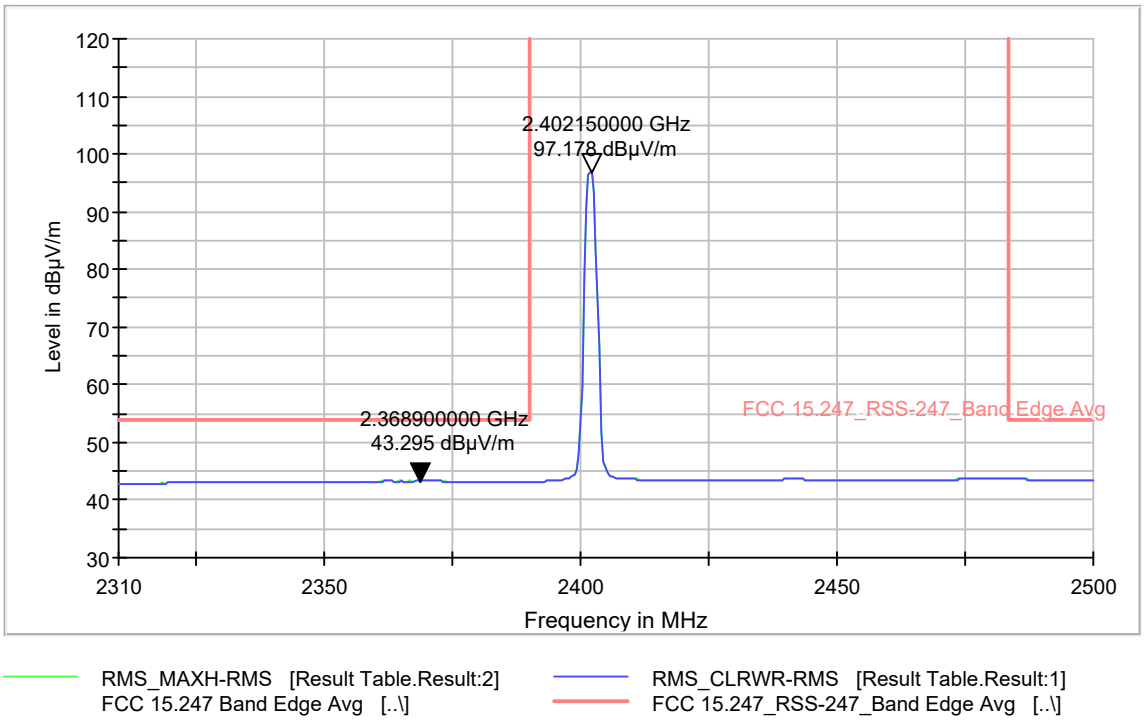
Plot 9-57. Restricted Band Edge 1-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Peak



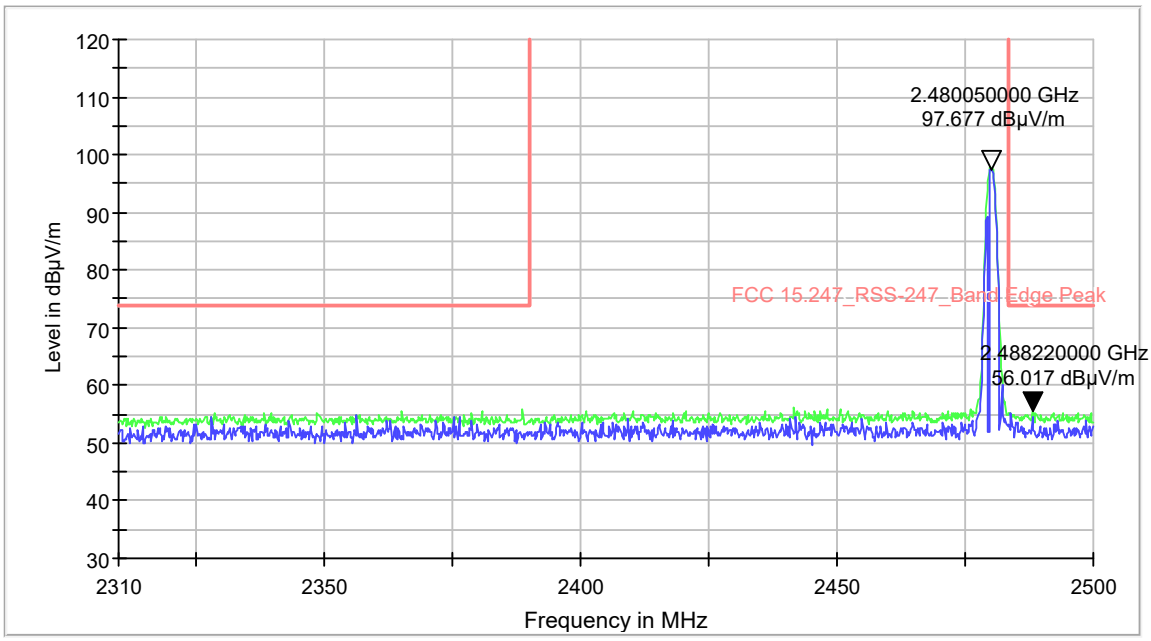
Plot 9-58. Restricted Band Edge 1-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Average



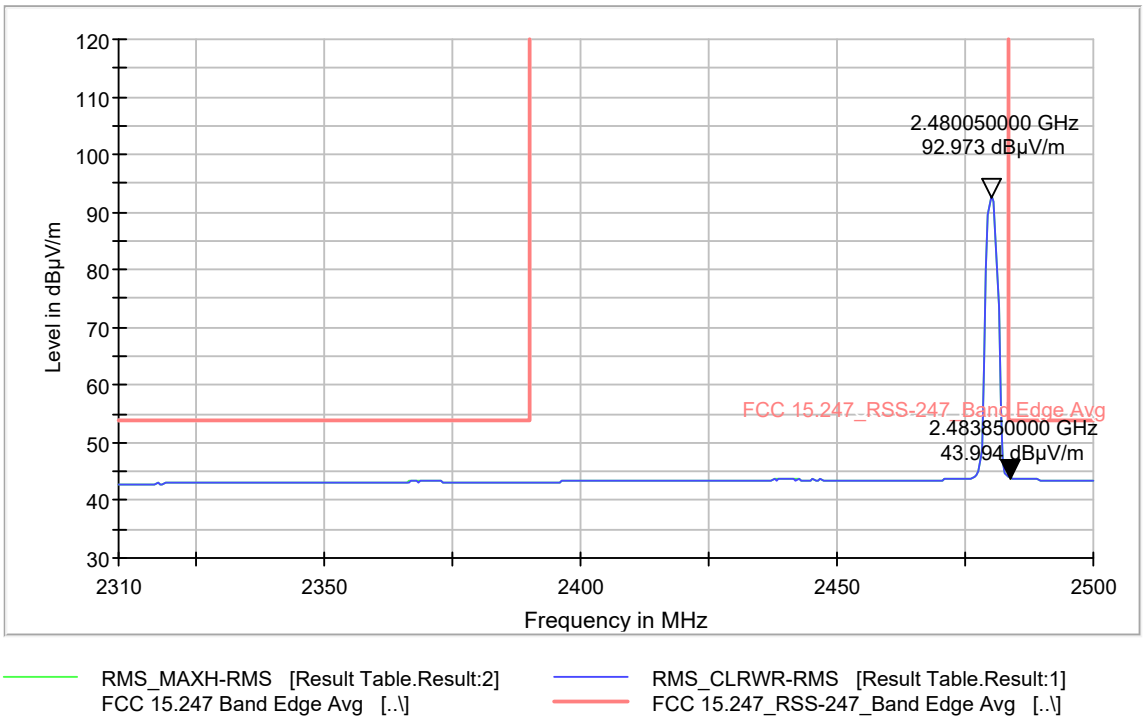
Plot 9-59. Restricted Band Edge 2-DH5 Mode– Ch. 0 (2310-2390MHz) – Peak



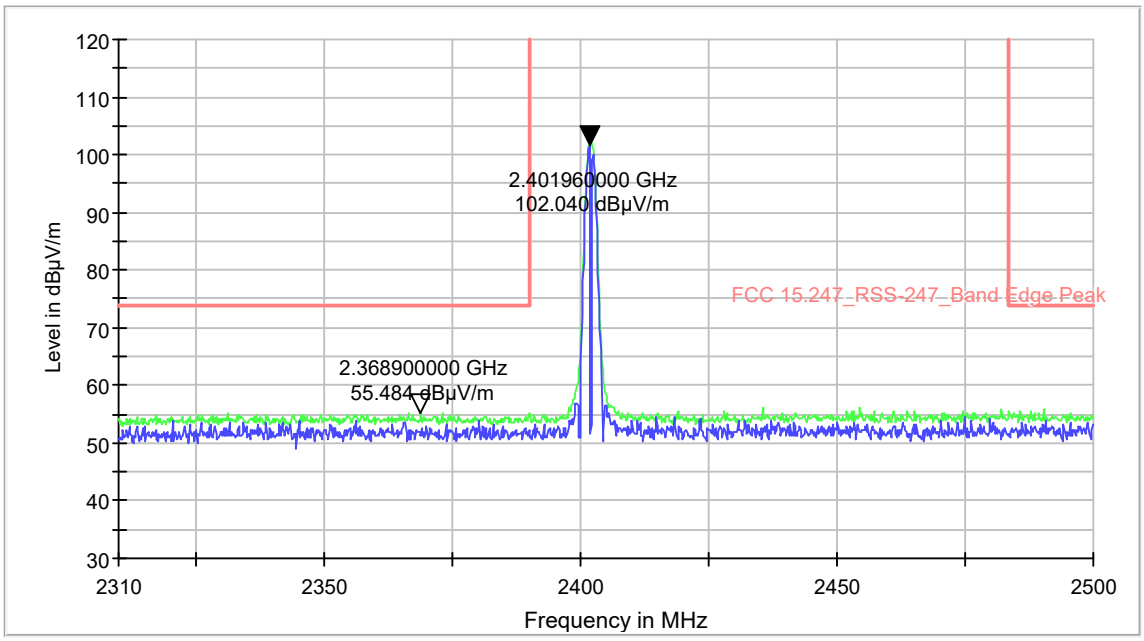
Plot 9-60. Restricted Band Edge 2-DH5 Mode– Ch. 0 (2310-2390MHz) - Average



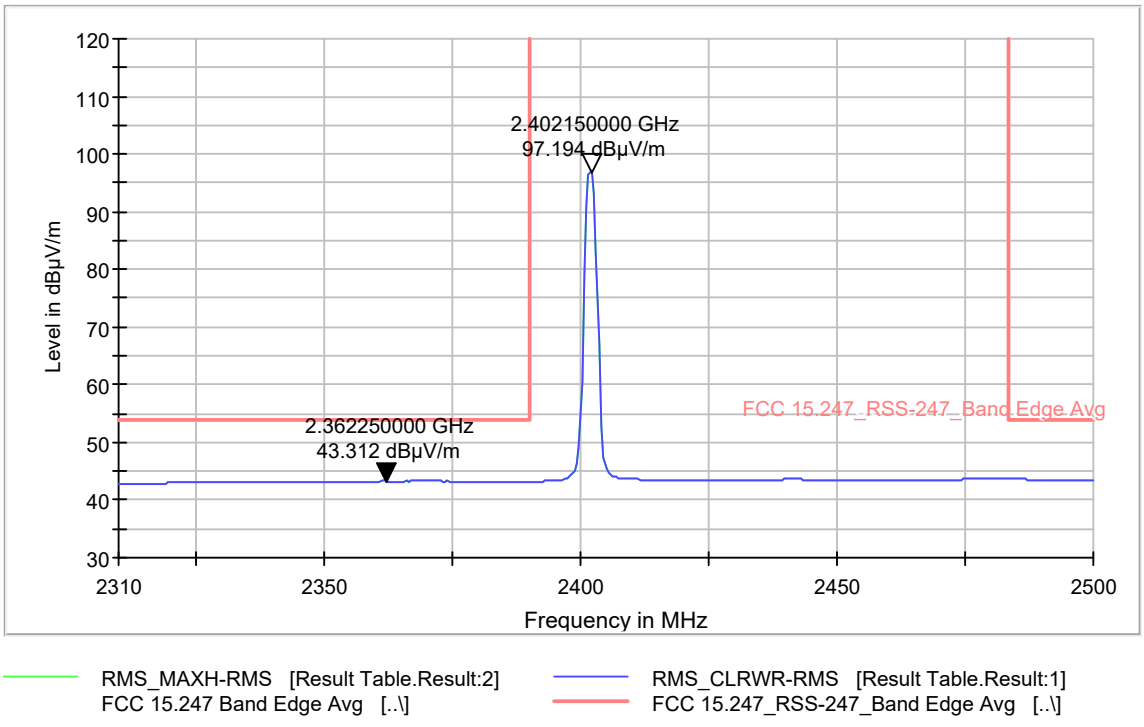
Plot 9-61. Restricted Band Edge 2-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Peak



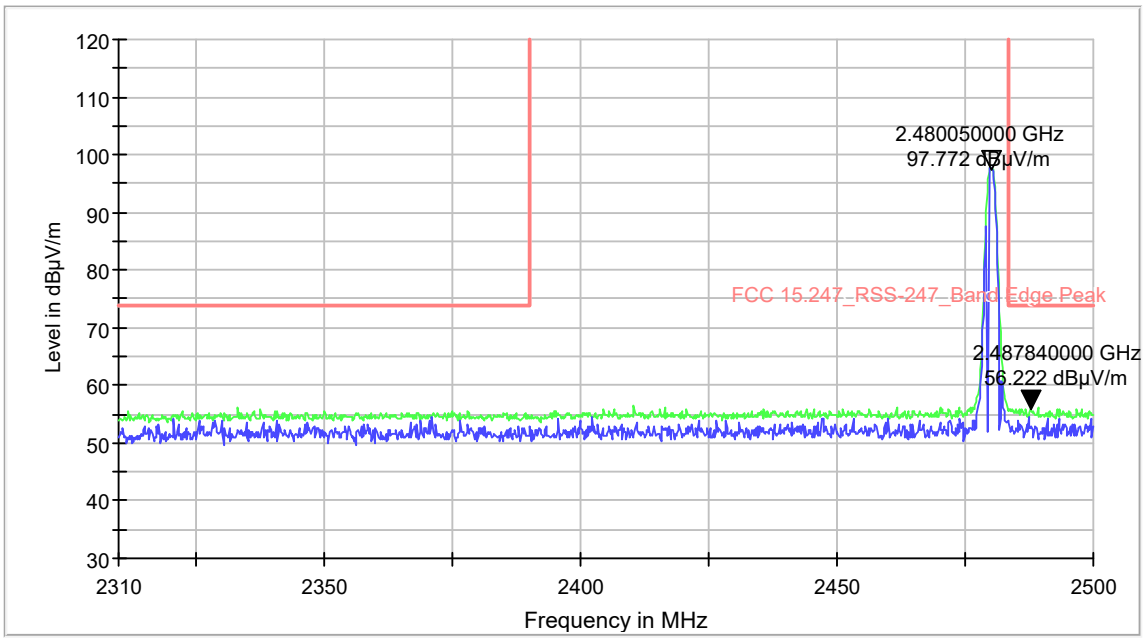
Plot 9-62. Restricted Band Edge 2-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Average



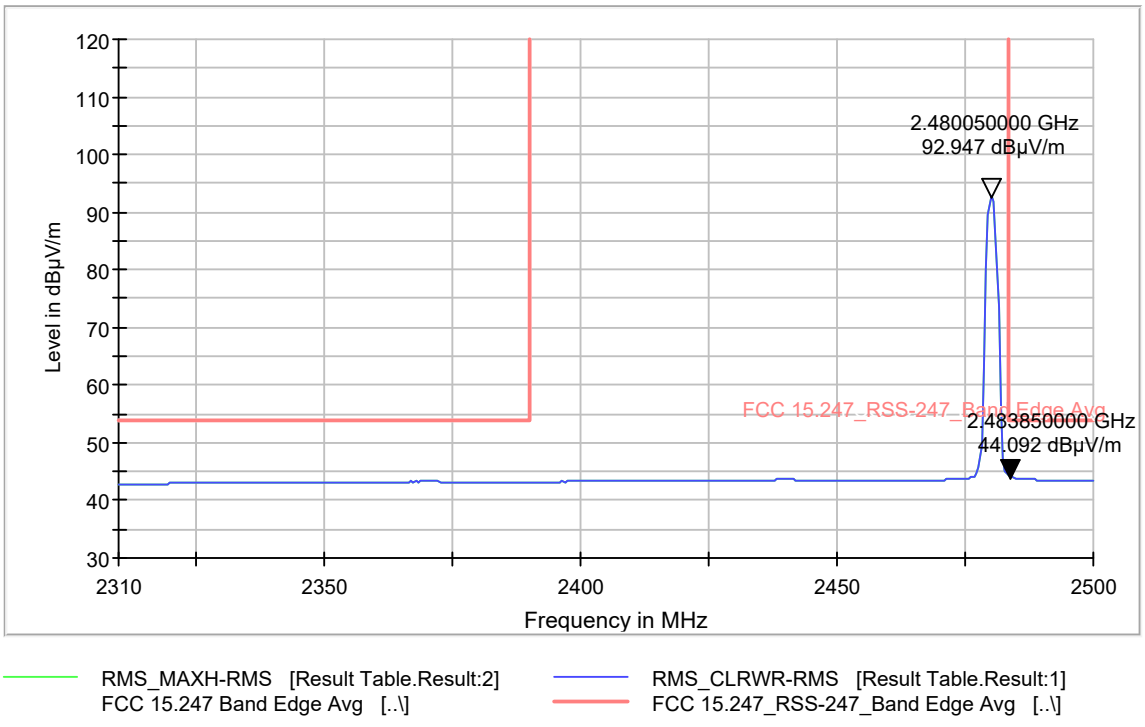
Plot 9-63. Restricted Band Edge 3-DH5 Mode– Ch. 0 (2310-2390MHz) – Peak



Plot 9-64. Restricted Band Edge 3-DH5 Mode– Ch. 0 (2310-2390MHz) - Average



Plot 9-65. Restricted Band Edge 3-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Peak

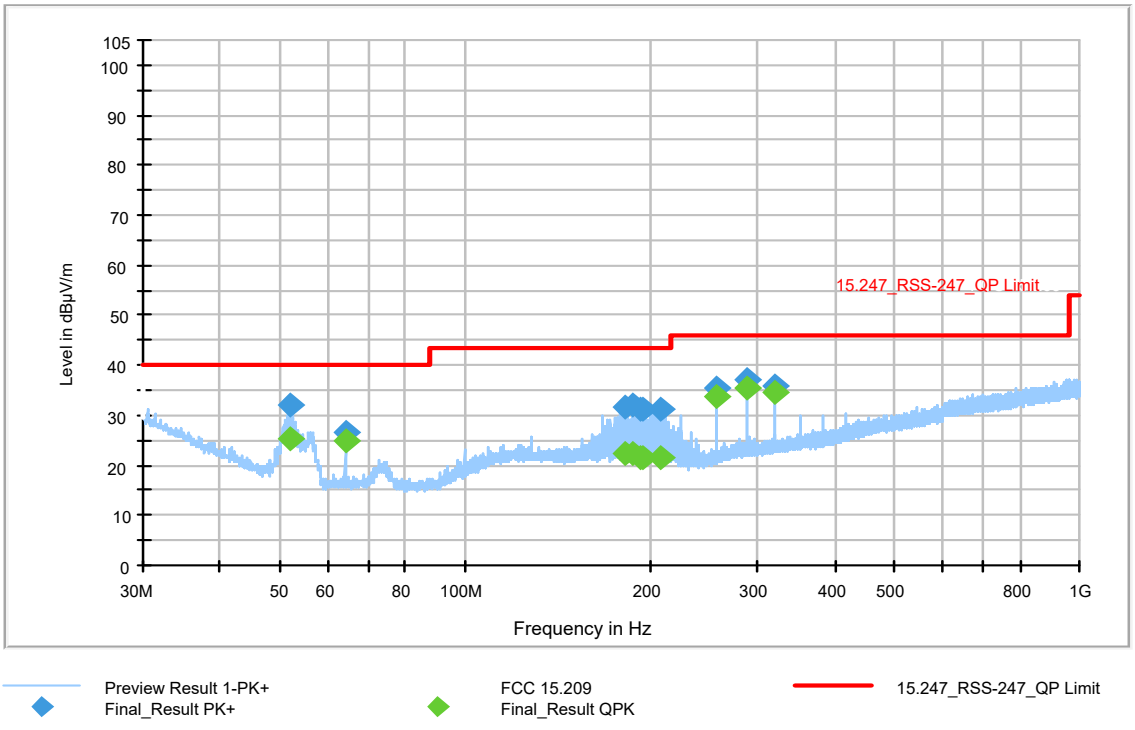


Plot 9-66. Restricted Band Edge 3-DH5 Mode– Ch. 78 (2483.5-2500MHz) - Average

9.9.5.2 Emissions in 30 MHz- 1 GHz range

All channels and modes of operations were tested and worst case emissions in 3DH5 mode, Ch 0 shown below.

Carrier Frequency (MHz)	Frequency (MHz)	Raw Quasi-Peak Field Strength (dBµV/m)	Correction Factor (dB)	Corrected Quasi-Peak Field Strength (dBµV/m)	QP Limit (dBµV/m)	Margin (dB)
2402	52.00	10.41	14.80	25.21	40.00	-14.79
2402	64.00	10.57	14.20	24.77	40.00	-15.23
2402	182.49	3.82	18.40	22.22	43.52	-21.30
2402	188.31	3.88	18.40	22.28	43.52	-21.24
2402	193.80	2.51	18.80	21.31	43.52	-22.21
2402	194.41	2.77	18.80	21.57	43.52	-21.95
2402	208.62	2.76	18.80	21.56	43.52	-21.96
2402	256.00	14.56	19.30	33.86	46.02	-12.16
2402	287.97	14.71	20.90	35.61	46.02	-10.41
2402	319.98	13.07	14.80	34.47	46.02	-11.55

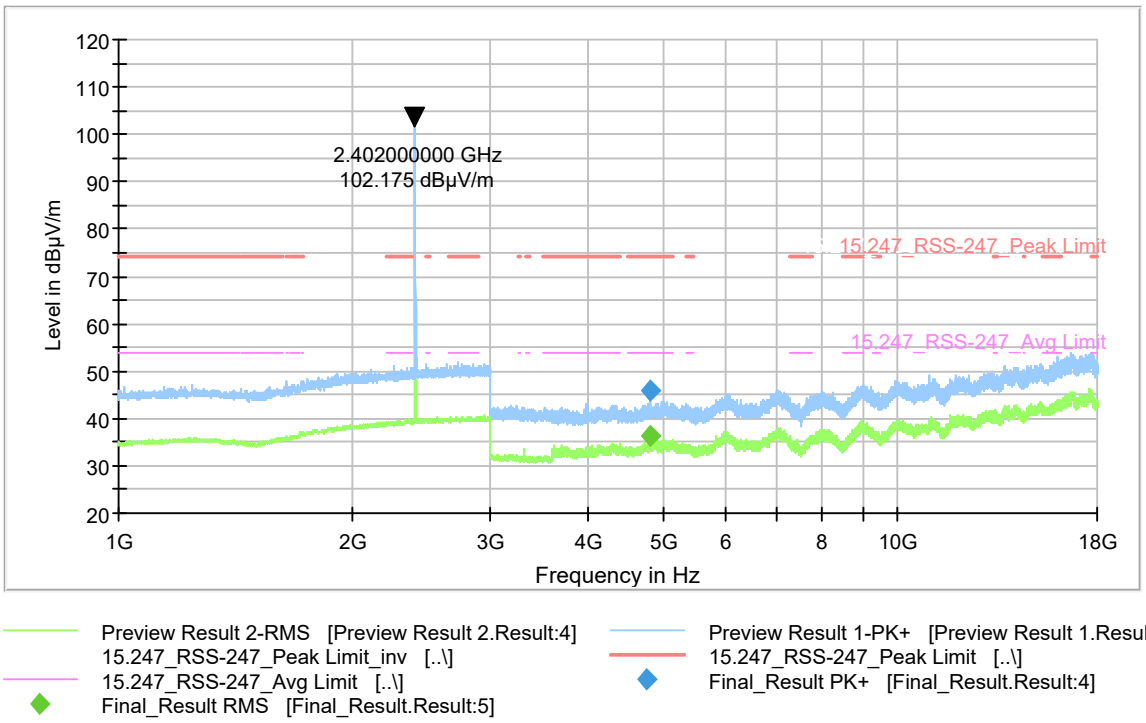


Plot 9-67. Radiated Spurious Emissions (Ch. 0) 3-DH5 (30MHz - 1GHz)

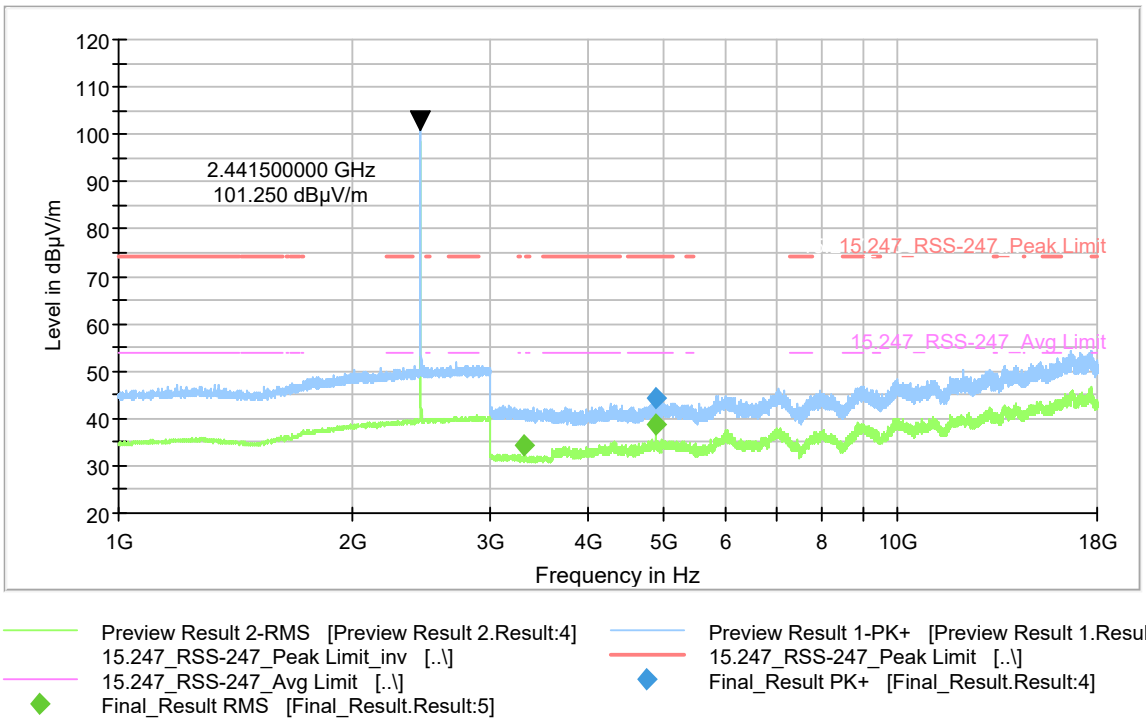
9.9.5.3 Emissions in 1-18 GHz range

RSE 1 - 18GHz Average Data							
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Avg. Amplitude (dBµV)**	**System Correction Factor (dB)**	**DC Correction Factor**	**Corrected Avg. Field Strength (dBµV/m)**	**Average Limit (dBµV/m)**	**Margin (dB)**
2402	4804.2	27.85	8.3	1.13	37.28	54	-16.72
2441	3312.2	27.60	6.6	1.13	35.33	54	-18.67
2441	4882.1	30.53	8.1	1.13	39.76	54	-14.24
2480	4960.2	33.90	8.0	1.13	43.03	54	-10.97

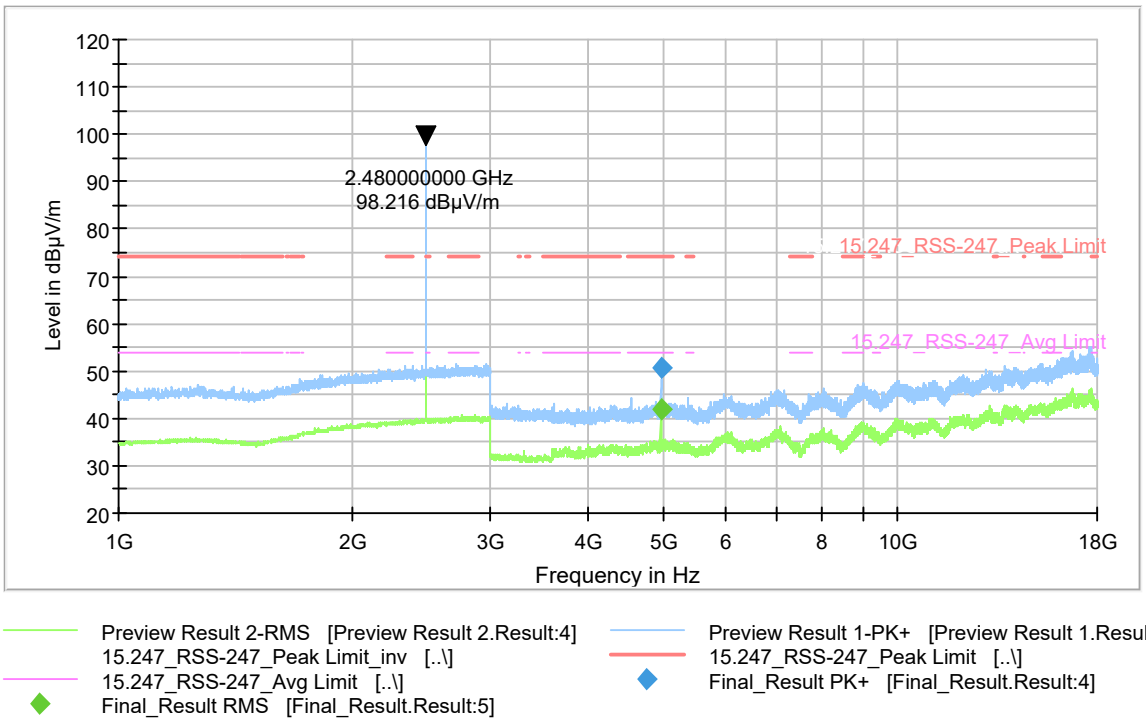
RSE 1 - 18GHz Peak Data						
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Peak Amplitude (dBµV)**	**Correction Factor (dB)**	**Corrected Peak Field Strength (dBµV/m)**	**Peak Limit (dBµV/m)**	**Margin (dB)**
2402	4804.5	37.66	8.3	45.96	74	-28.04
2441	4892.5	35.95	8.4	44.35	74	-29.65
2480	4959.8	42.66	8.0	50.66	74	-23.34



Plot 9-68. Radiated Spurious Emissions (Ch. 0) (1-18 GHz)



Plot 9-69. Radiated Spurious Emissions (Ch. 39) (1-18 GHz)

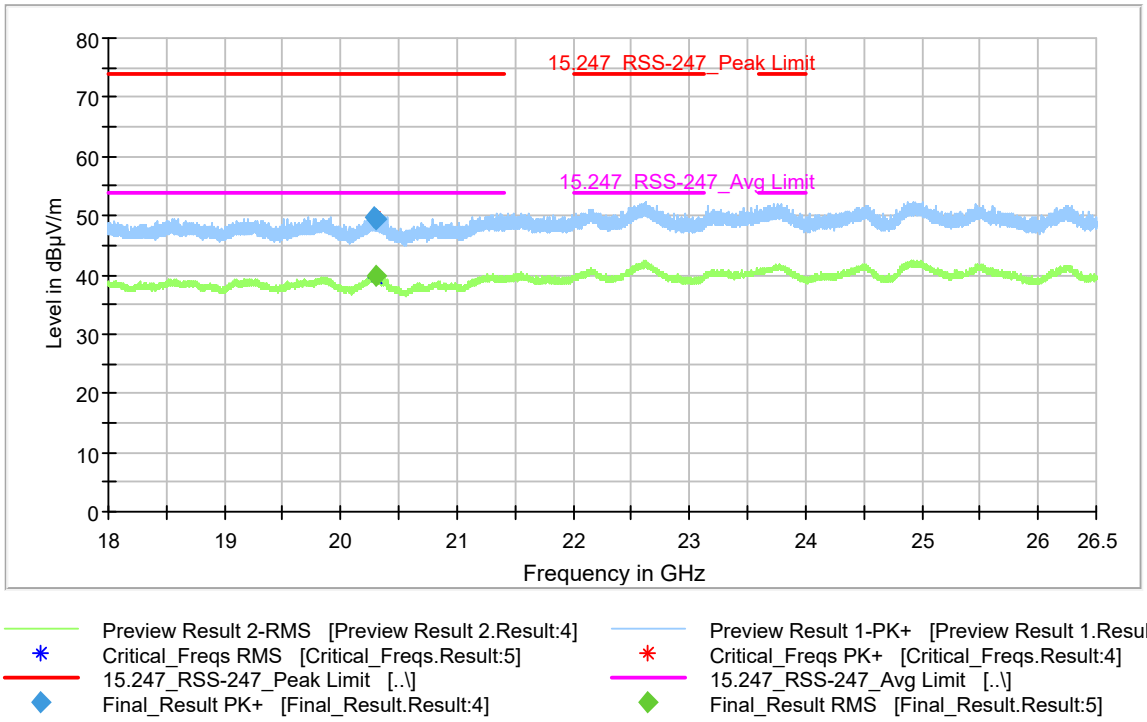


Plot 9-70. Radiated Spurious Emissions (Ch. 78) (1-18 GHz)

9.9.5.4 Emissions in 18-26.5 GHz range

All channels and modes of operations were tested and worst case emissions in 3DH5 mode, Ch 0 shown below. No significant emissions above noise floor.

RSE 18 – 26.5 GHz Average Data						
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Avg. Amplitude (dBµV)**	**Correction Factor (incl DCF) (dB)**	**Corrected Avg. Field Strength (dBµV/m)**	**Average Limit (dBµV/m)**	**Margin (dB)**
2402	20301.96	28.63	12.23	40.86	54	-13.14
RSE – 18 – 26.5 GHz 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	20281.71	38.54	11.20	49.74	74	-24.26
2402	20302.89	38.31	11.10	49.41	74	-24.59



Plot 9-71. Radiated Spurious Emissions (Ch. 0) (18-26.5 GHz)

9.10 AC Line Conducted Emissions

9.10.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)

ISED RSS Gen [8.8]

9.10.2 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 is set to continuously transmit on Ch.0.

EMI Receiver Settings:
150 kHz – 30 MHz:
RBW= 9 kHz
VBW ≥ 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

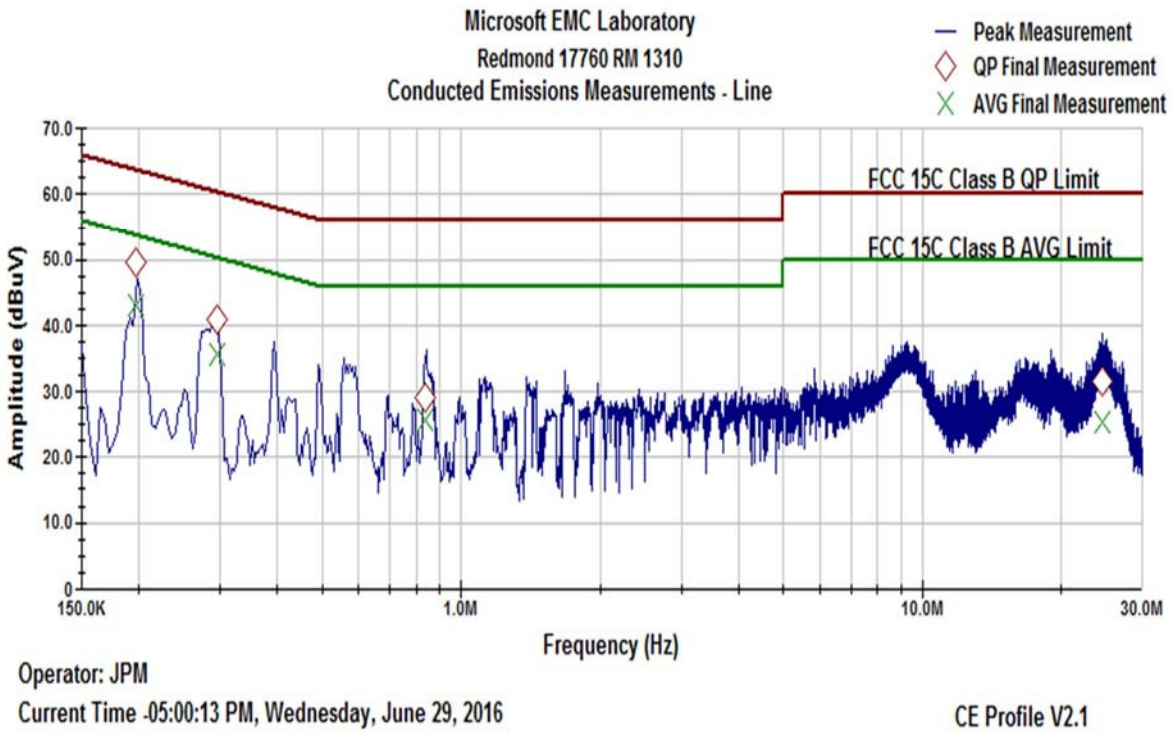
9.10.3 Limit

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

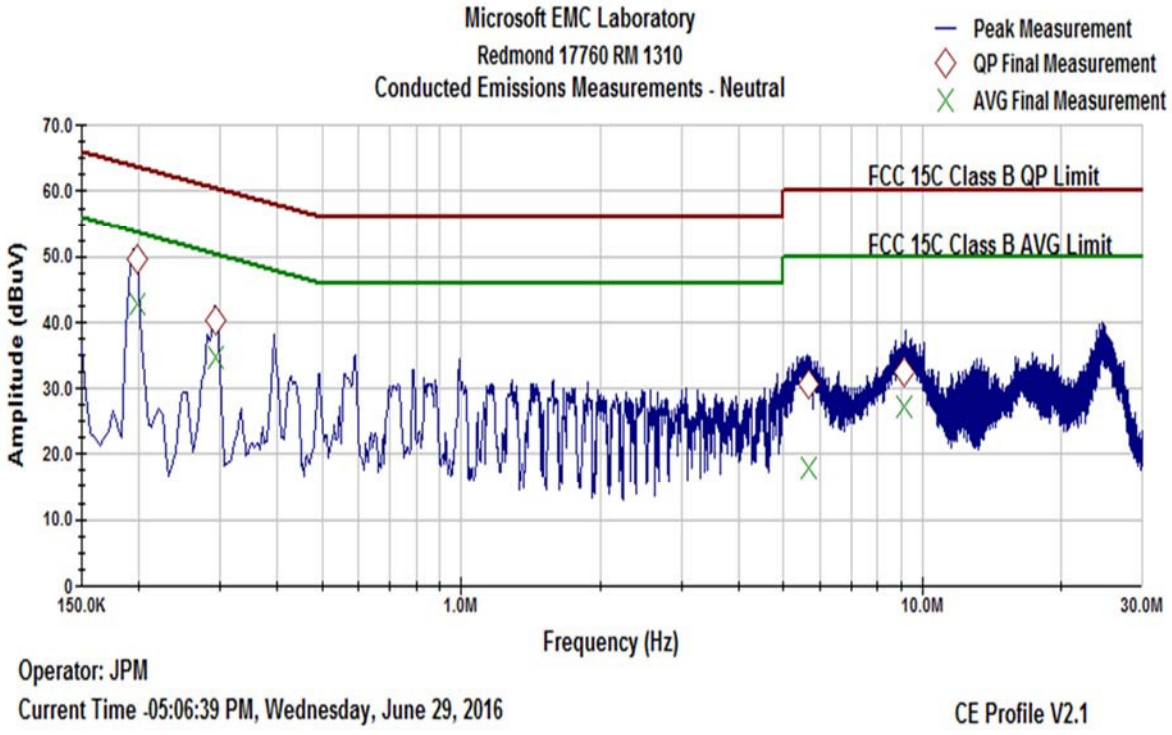
9.10.4 Test Result:

Pass

9.10.5 Test Data:



Plot 9-72. AC Line Conducted Emissions- Line (150 kHz- 30 MHz)



Plot 9-73. AC Line Conducted Emissions- Neutral (150 kHz- 30 MHz)

Frequency (MHz)	QP Net Reading (dBµV)	AVG Net Reading (dBµV)	Quasi-Peak Limit (dBµV)	Average Limit (dBµV)	Line Tested (L or N)	Quasi-Peak Margin (dB)	Average Margin (dB)
0.198	49.72	43.18	64.64	54.64	L	-14.92	-11.47
0.198	49.43	42.85	64.62	54.62	N	-15.19	-11.77
0.296	40.92	35.46	61.84	51.84	L	-20.92	-16.38
0.295	40.19	34.65	61.87	51.87	N	-21.67	-17.22
0.837	29.13	25.68	56.00	46.00	L	-26.87	-20.32
9.144	32.62	27.12	60.00	50.00	N	-27.38	-22.88
24.538	31.51	25.52	60.00	50.00	L	-28.49	-24.48
5.654	30.51	18.07	60.00	50.00	N	-29.49	-31.93

End of Report