



# RADIO TEST REPORT

For

MODEL NO.: 1843

FCC ID: C3K1843

IC ID: 3048A-1843

Test Report No. R-TR525-FCCISED-BT-2

Issue Date: May 3, 2019

FCC CFR47 Part 15 Subpart C  
Innovation, Science and Economic Development  
Canada RSS-247 Issue 2

*Prepared by*  
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TESTING CERT #3472.01

[illegible]

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# Test Report Attestation

**Microsoft Corporation****Model:** 1843**FCC ID:** C3K1843**IC ID:** 3048A-1843**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 2, RSS-GEN Issue 5	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 pertain 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 report R-TR525-FCCISED-BT-1 issued April 23, 2019.



Written By: Vishwas Narayan  
Radio Test Engineer



Reviewed/ Issued By: Daniel Salinas  
RF Compliance Lab Technical 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 67<sup>th</sup> 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 (9 kHz to 30 MHz)	5.32	dB
Radiated disturbance (30 MHz to 1 GHz)	5.99	dB
Radiated disturbance (1 GHz to 18 GHz)	5.12	dB
Radiated disturbance (18 GHz to 26.5 GHz)	4.86	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	°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:	Choon Sian Ooi
Functional Description of the EUT:	Smart Display with 802.11a/b/g/n/ac 20/40/80/160 MHz, Bluetooth 5.0, and 24.2 GHz Sensor Radios
Model:	1843
FCC ID:	C3K1843
IC ID:	3048A-1843
Radio under test:	BT (2402- 2480 MHz) Ch. 0-78
Modulation(s):	GFSK, $\pi/4$ -DQPSK, 8PSK
Antenna Information:	Integral Antenna. <b>Manufacturer declared max Antenna Gain in 2.4GHz band of operation: 3.60 dBi</b>
EUT Classification:	FHSS
Equipment Design State:	Prototype/Production Equivalent – EV4
Equipment Condition:	Good
Test Sample Details:	<b>RF Conducted Test Sample</b> S/N: 17566293000013M, Internal ID: R-525-012219-01  <b>RF Radiated Test Sample</b> S/N:000059790462, Internal ID: R-525-021419-01 S/N:000052790462, Internal ID: R-525-021419-02

### 5.1 Test Configurations

Test software “DRTU” (V11.846.0-08758) provided by the customer was used to program the EUT to transmit continuously.

The device can operate in GFSK,  $\pi/4$ DQPSK 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 °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 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 January 28<sup>th</sup>, 2019 to April 3<sup>rd</sup>, 2019.

## 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)(1) RSS-247 [5.4]	< 125 mW – Conducted < 500 mW - 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]	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 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
Agilent	Spectrum Analyzer	N9030A	EMC-370	10/19/2019
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-192	4/8/2019
Rohde & Schwarz	EMI Test Receiver	ESR26	RF-568	4/11/2019
Rohde & Schwarz	Open Switch and Control Unit	OSP130	RF-018	N/A
Rohde & Schwarz	Open Switch and Control Unit	OSP130	RF-019	N/A
Rohde & Schwarz	Open Switch and Control Unit	OSP130	RF-569	N/A
Rohde & Schwarz	Custom Filter Bank	SFUNIT RX	RF-322	N/A
ETS-Lindgren	Antenna - Double-Ridged Guide	3117-PA	EMC-858	10/8/2019
ETS-Lindgren	Antenna - Standard Gain	3160-09	RF-179	7/30/2019
Sunol Sciences	Antenna - Broadband Hybrid	JB6	EMC-639	8/17/2019
Pasternack	6dB Attenuator	PE7004-6	EMC-950	8/17/2019
Pasternack	10dB Attenuator	PE7087-10	EMC-653	1/21/2020
Pasternack	10dB Attenuator	PE7087-10	RF-125	9/18/2019
Utiflex	RF Cable	OSP120/DUT3	RF-872	10/4/2019
Utiflex	RF Cable	OSP120/DUT8	RF-869	10/4/2019
Mouser	RF Cable	CabS02	RF-937	11/15/2019

Equipment used for Radiated and Conducted Measurements				
Manufacturer	Description	Model #	Asset #	Calibration Due
Huber and Suhner	RF Cable	Sucoflex 100	RF-452	N/A
Micro-Coax	RF Cable	UFA210A-Q-2755-3005GU	EMC-648	N/A
Micro-Coax	RF Cable	UFB311A-1-0787-50U50U	EMC-351	N/A
Micro-Coax	RF Cable	UTI Flex	RF-359	N/A
Micro-Coax	RF Cable	UTI Flex	RF-647	N/A
Micro-Coax	RF Cable	UTI Flex	RF-646	N/A
Huber & Suhner	RF Cable	Sucoflex 102A	RF-269	N/A
Rohde & Schwarz	Pre-Amplifier	TS-PR26	RF-199	11/29/2019
PCE	Climate Meter	PCE-THB 40	EMC-1206	9/28/2019
Madge Tech	THP Monitor	PRHTemp2000	EMC-838	3/5/2019*
Madge Tech	THP Monitor	PRHTemp2000	EMC-170	10/18/2019

Equipment used for AC Line Conducted Emissions Measurement				
Manufacturer	Description	Model #	Asset #	Calibration Due
Rohde & Schwarz	Analyzer/Receiver	ESR3	EMC-669	4/8/2019
Teseq	EUT LISN	NNB 051	EMC-056	6/7/2019
Micro-Coax	Cable	UFA210A-1-1800-50U50U	EMC-367	N/A
ETS-Lindgren	TILE Profile	Version 7.2.5.7	EMC-985	N/A
Fluke	Multimeter	87V	EMC-192	10/18/2019
MadgeTech	Environmental Monitor	PRHTemp2000	EMC-680	11/16/2019
Chroma	AC Power Source	61602	EMC-055	N/A

Note: Items with Calibration Due data marked as N/A are characterized before test, where applicable.

Note\*: Equipment was within calibration during test.

## 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. Measurements below 30 MHz were performed on a site demonstrating equivalence to an open field site per KDB 414788 D01.

#### 8.1.1 Radiated Measurements in 9kHz- 30 MHz

The EUT is positioned as a floor standing device with center of the EUT aligned with the center of the turntable. A loop antenna is positioned at 3m from the EUT periphery at 1m height from the ground. The turntable is rotated 360 degrees to determine the highest emissions. This is repeated for three orientations of the measurement antenna- parallel, perpendicular and ground-parallel. All possible orientations of the EUT were investigated for emissions and the landscape orientation was identified as the worst-case configuration.

#### 8.1.2 Radiated Measurements in 30 MHz - 1000 MHz

The EUT is positioned as a floor standing device with center of the EUT aligned with the center of the turntable. 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 landscape orientation was identified as the worst-case configuration.

#### 8.1.3 Radiated Measurements above 1GHz

The EUT is positioned as a floor standing device with center of the EUT aligned with the center of the turntable. 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 measurement antenna height is varied from 1m to 4m while the turntable is rotated 360 degrees 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 3m distance. Near field scanning is performed to identify frequencies above 1 GHz.

### 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 these correction factors into account.

### 8.3 Test Setup Diagrams

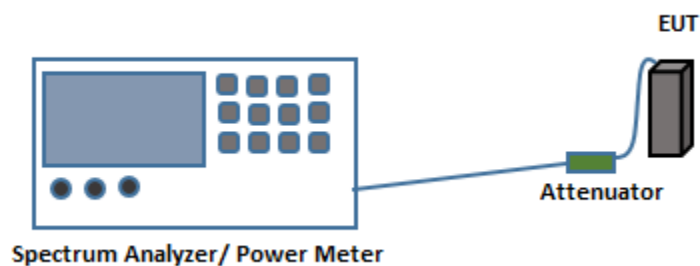


Fig.1. Test Setup for Antenna port conducted measurements

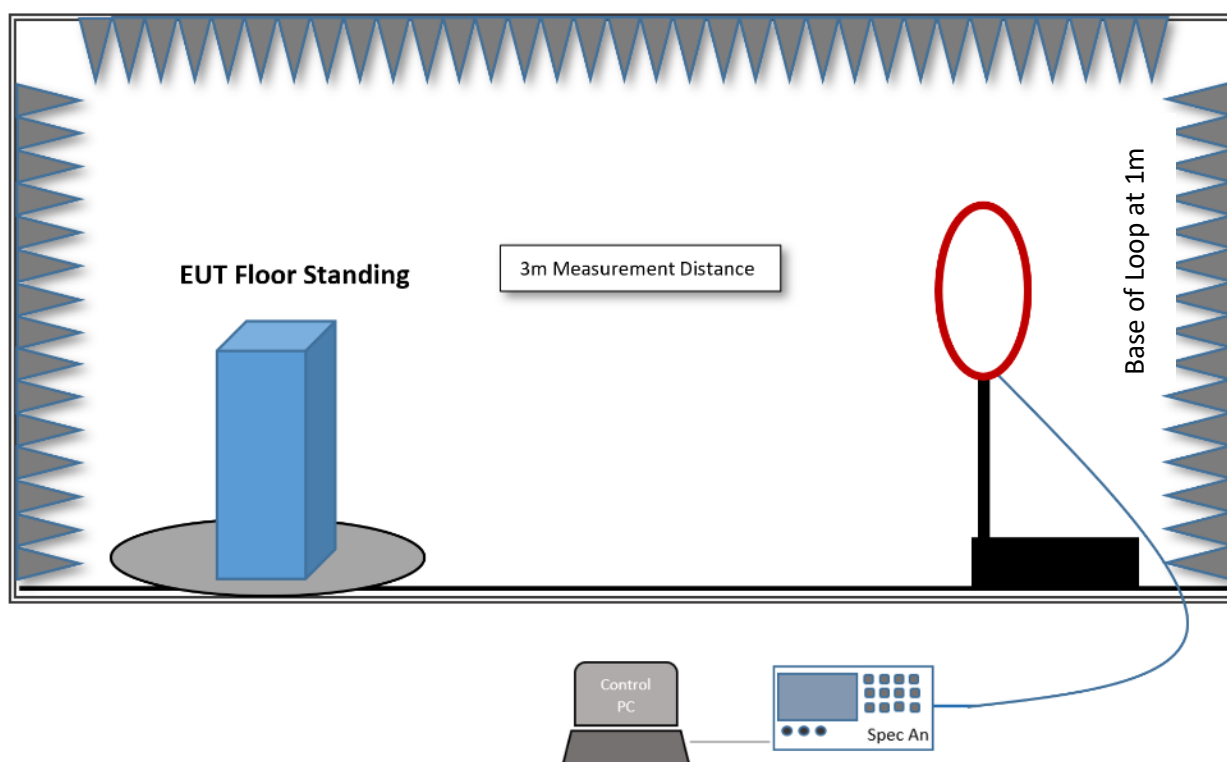


Fig.2. Test Setup for Radiated measurements in 9kHz - 30MHz Range

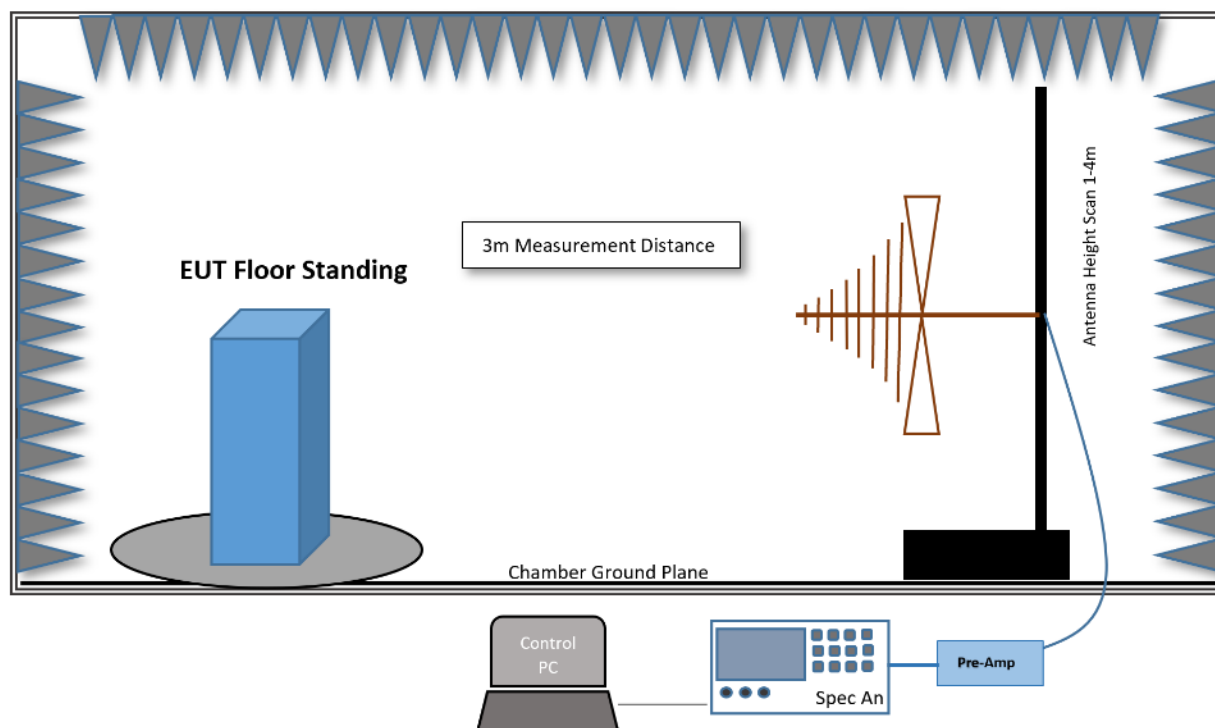


Fig.3. Test Setup for Radiated measurements in 30MHz- 1GHz Range

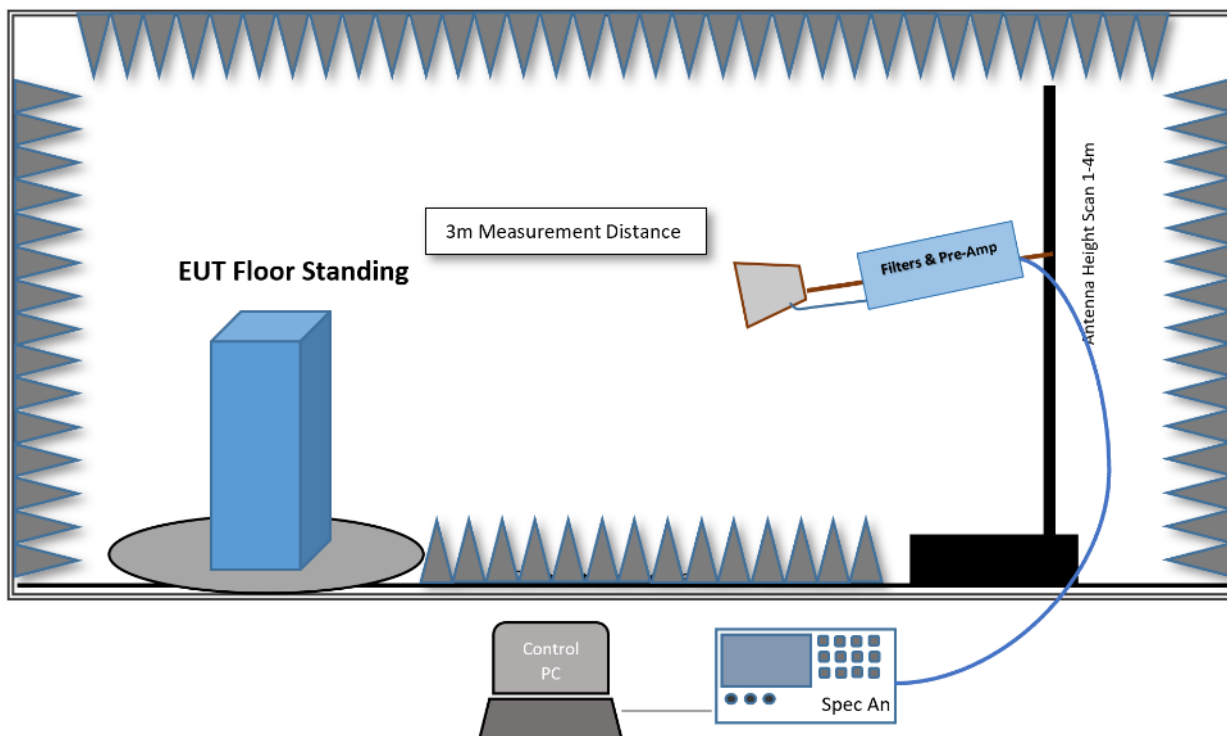


Fig.4. Test Setup for Radiated measurements in 1GHz- 18GHz Range

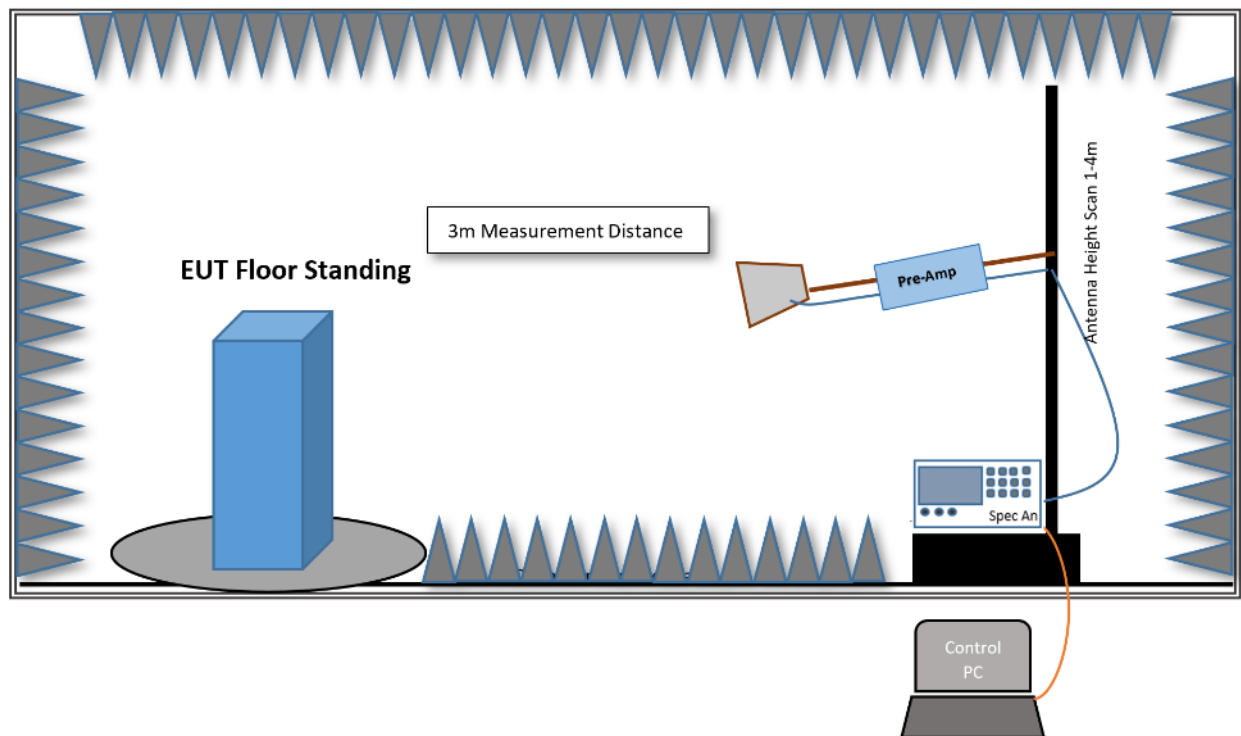


Fig.5. Test Setup for Radiated measurements >18GHz



## 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.

#### Spectrum Analyzer Settings:

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

VBW  $\geq$  RBW  $\geq$  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	0.380	1.250	30.424	5.168
2402	1-DH3	1.635	2.501	65.374	1.846
2402	1-DH5	2.883	3.749	76.901	1.141

## 9.1.5 Test Data:

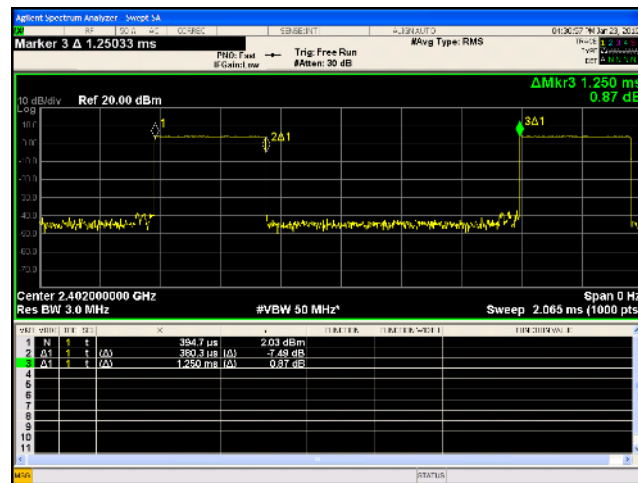


Figure 9-1 Duty Cycle (Ch. 0, 1-DH1)

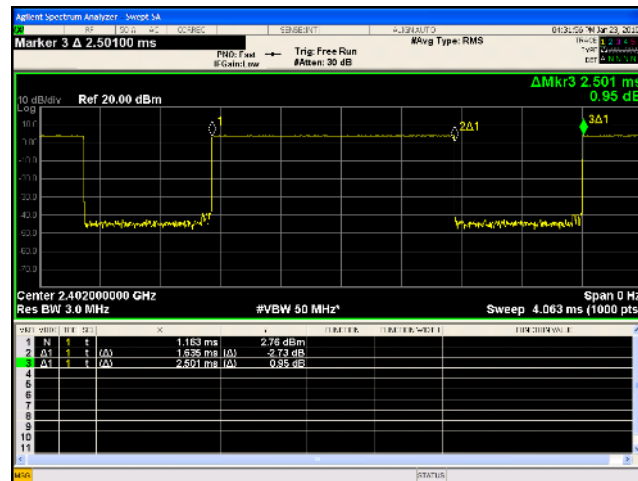


Figure 9-2 Duty Cycle (Ch. 0, 1-DH3)

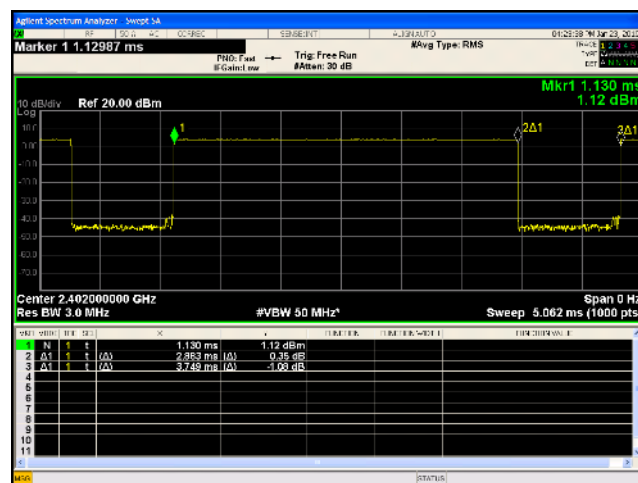


Figure 9-3 Duty Cycle (Ch. 0, 1-DH5)

## 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 ANSI C63.10:2013 Section 7.8.

#### 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 or 99% Occupied bandwidth, centered on a hopping channel

RBW  $\geq$  1 to 5 % of the 20dB bandwidth= 24kHz

VBW  $\geq$  3x RBW= 75kHz

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 (MHz)	Occupied Bandwidth (MHz)
2402	1-DH5	1	0	0.948	0.888
2441	1-DH5	1	39	0.948	0.876
2480	1-DH5	1	78	0.948	0.877
2402	2-DH5	2	0	1.490	1.354
2441	2-DH5	2	39	1.488	1.354
2480	2-DH5	2	78	1.490	1.353
2402	3-DH5	3	0	1.447	1.354
2441	3-DH5	3	39	1.447	1.356
2480	3-DH5	3	78	1.447	1.356

## 9.2.5 Test Data:

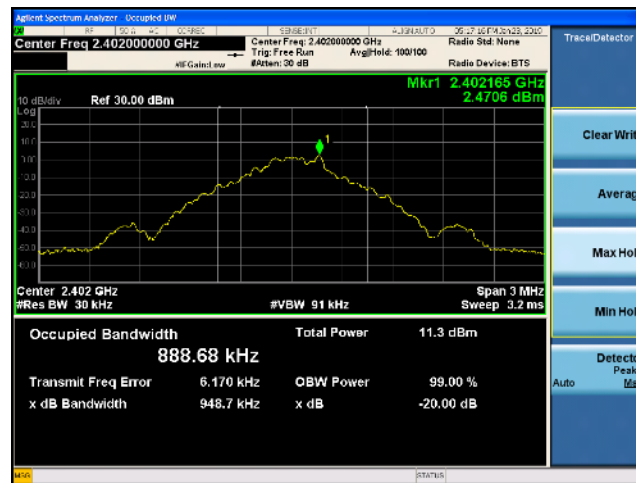


Figure 9-4 20dB Bandwidth (Ch. 0, 1-DH5)



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



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

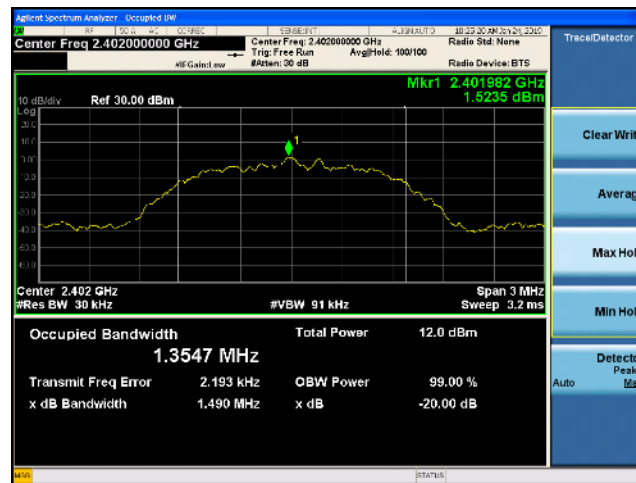


Figure 9-7 20dB Bandwidth (Ch. 0, 2-DH5)

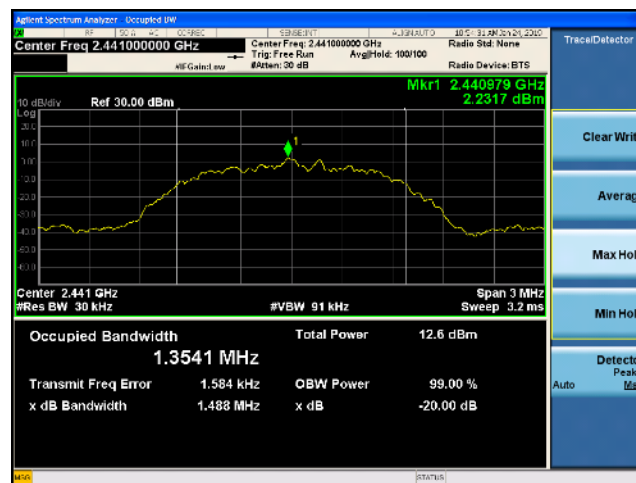


Figure 9-8 20dB Bandwidth (Ch. 39, 2-DH5)



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

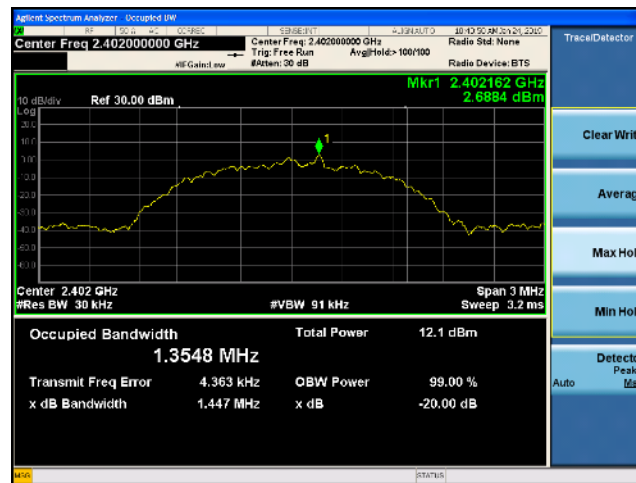


Figure 9-10 20dB Bandwidth (Ch. 0, 3-DH5)



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

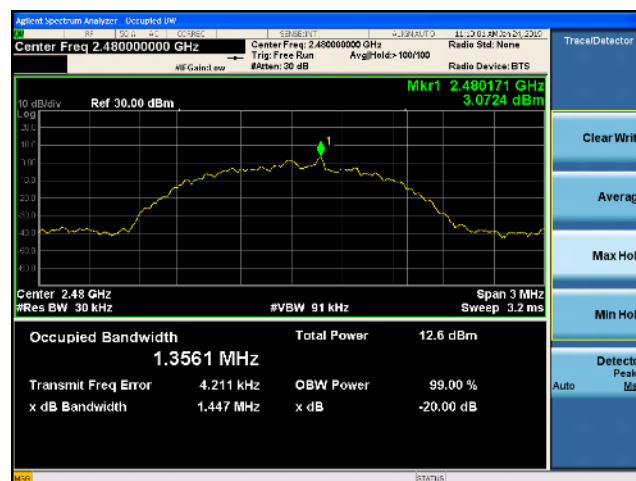


Figure 9-12 20dB Bandwidth (Ch. 78, 3-DH5)

## 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 ANSI C63.10:2013 Section 7.8.

#### **Spectrum analyzer settings:**

##### **Peak Power Measurements:**

Span = approximately 5 times the 20-dB bandwidth, centered on a hopping channel= 5MHz

RBW > the 20-dB bandwidth of the emission being measured= 2MHz

VBW  $\geq 3 \times$  RBW= 6MHz

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/RSS-247: 1 Watt (30dBm), if  $\geq 75$  non-overlapping channels.

Additionally, for EDR modes and devices with  $\leq 75$  non-overlapping channels (AFH), 21dBm conducted.

RSS-247: 4 W (36dBm) EIRP.

Additionally, for EDR modes and devices with  $\leq 75$  non-overlapping channels (AFH), 27dBm EIRP.

### 9.3.4 Test Results:

Frequency (MHz)	Mode	Data Rate (Mbps)	Channel No.	Cond. Peak Power (dBm)	Cond. Limit (dBm)	Margin (dBm)	Results
2402	1-DH5	1	0	3.89	21	-17.11	Pass
2441	1-DH5	1	39	4.51	21	-16.49	Pass
2480	1-DH5	1	78	4.30	21	-16.70	Pass
2402	2-DH5	2	0	6.02	21	-14.98	Pass
2441	2-DH5	2	39	6.58	21	-14.42	Pass
2480	2-DH5	2	78	6.40	21	-14.60	Pass
2402	3-DH5	3	0	6.16	21	-14.84	Pass
2441	3-DH5	3	39	6.82	21	-14.18	Pass
2480	3-DH5	3	78	6.58	21	-14.42	Pass

Frequency (MHz)	Mode	Channel No.	Cond. Peak Power (dBm)	Ant. Gain (dBi)	EIRP (dBm)	ISED EIRP Limit (dBm)	Margin (dBm)	Results
2402	1-DH5	0	3.89	4	7.89	36	-28.11	Pass
2441	1-DH5	39	4.51	4	8.51	36	-27.49	Pass
2480	1-DH5	78	4.30	4	8.30	36	-27.70	Pass
2402	2-DH5	0	6.02	4	10.02	26.9	-16.88	Pass
2441	2-DH5	39	6.58	4	10.58	26.9	-16.32	Pass
2480	2-DH5	78	6.40	4	10.40	26.9	-16.50	Pass
2402	3-DH5	0	6.16	4	10.16	26.9	-16.74	Pass
2441	3-DH5	39	6.82	4	10.82	26.9	-16.08	Pass
2480	3-DH5	78	6.58	4	10.58	26.9	-16.32	Pass



### 9.3.5 Test Data:

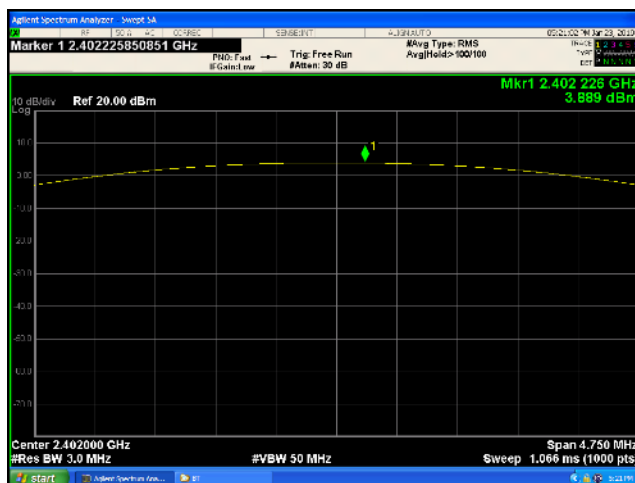


Figure 9-23 Peak Power (Ch. 0, 1-DH5)

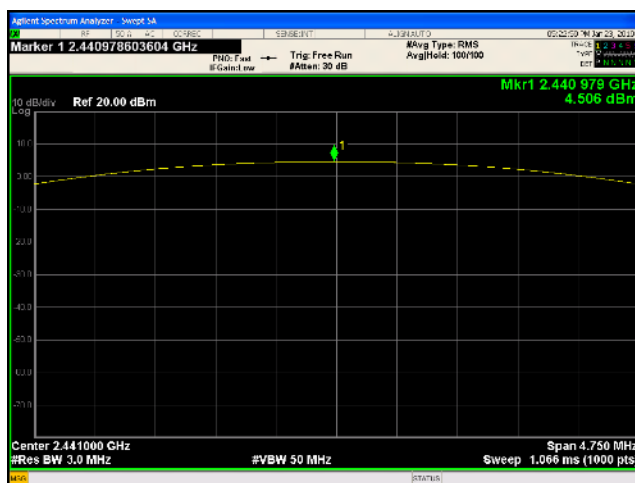


Figure 9-34 Peak Power (Ch. 39, 1-DH5)

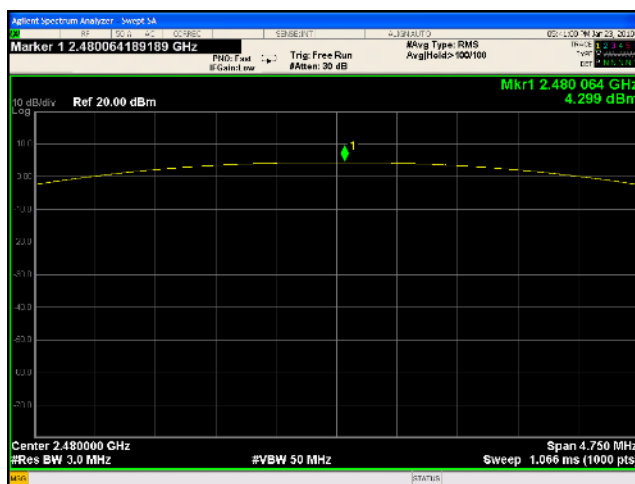


Figure 9-45 Peak Power (Ch. 78, 1-DH5)

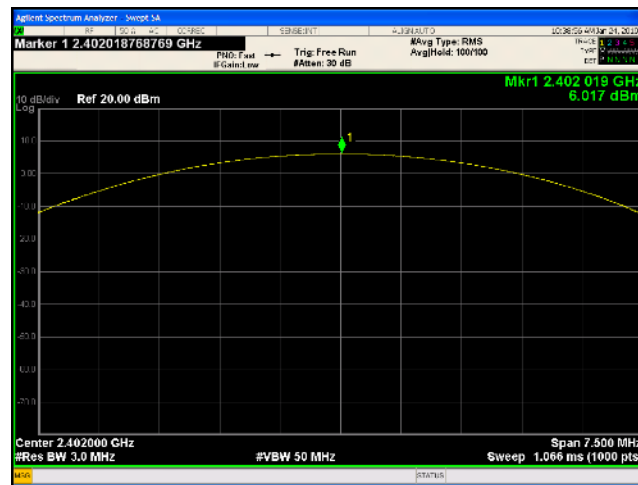


Figure 9-56 Peak Power (Ch. 0, 2-DH5)

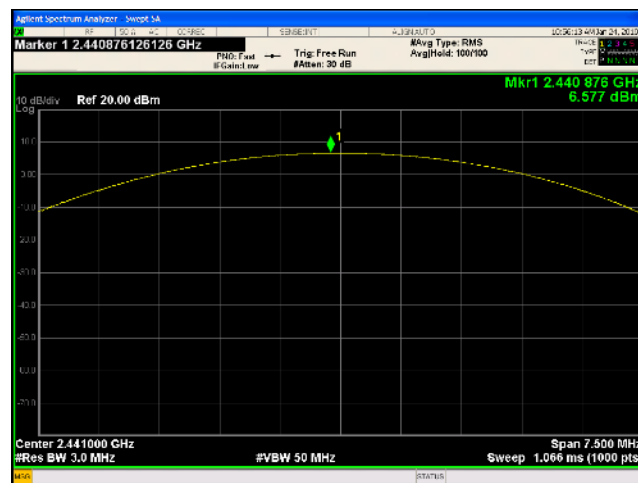


Figure 9-67 Peak Power (Ch. 39, 2-DH5)

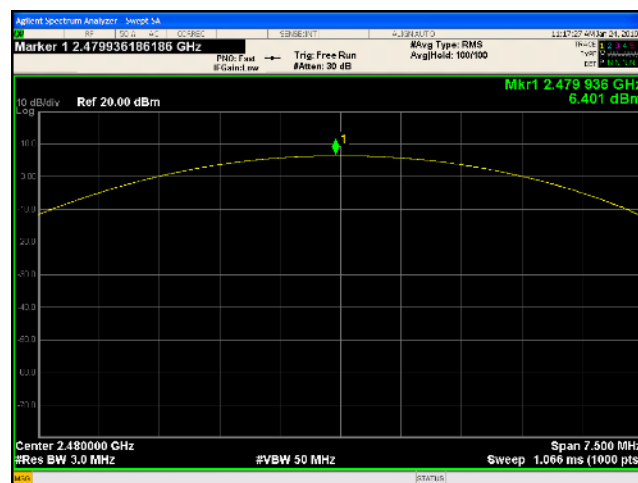


Figure 9-18 Peak Power (Ch. 78, 2-DH5)

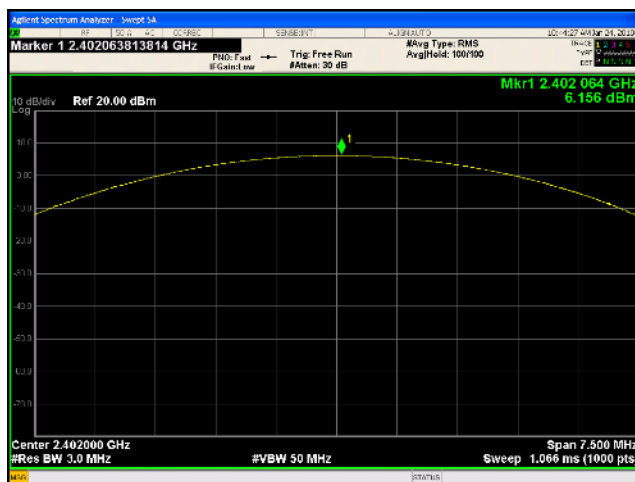


Figure 9-79 Peak Power (Ch. 0, 3-DH5)

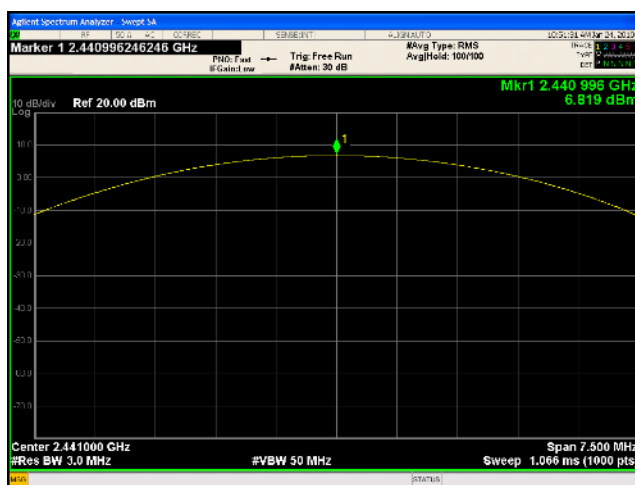


Figure 9-20 Peak Power (Ch. 39, 3-DH5)

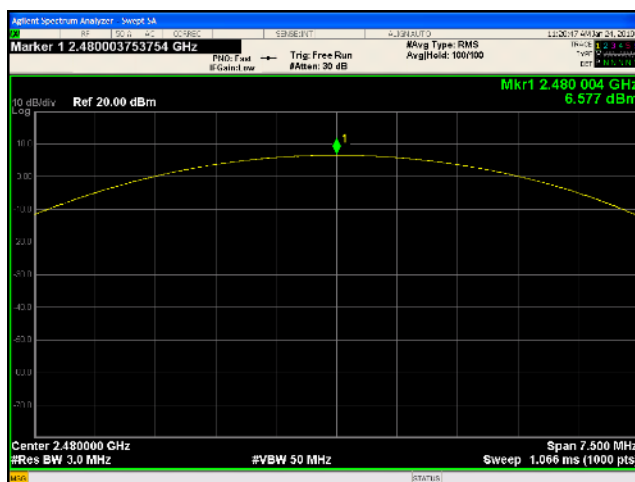


Figure 9-21 Peak Power (Ch. 78, 3-DH5)

## 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 ANSI C63.10:2013 Section 7.8. 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)  $\geq$  RBW = 3 MHz

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= 1.009 MHz in 1-DH5 Mode.

## 9.4.5 Test Data:

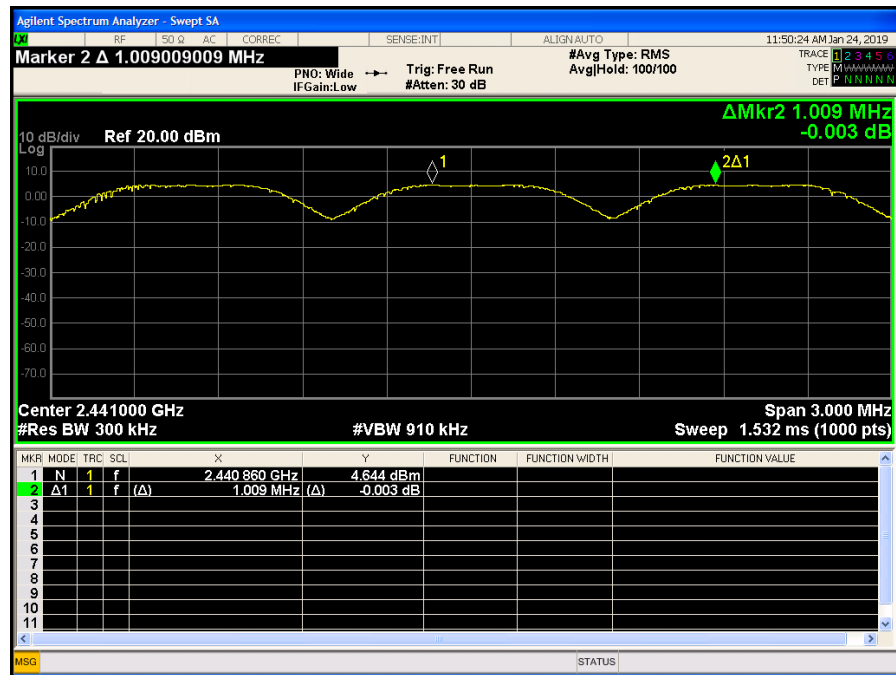


Figure 9-22 Channel Separation

## 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 ANSI C63.10:2013 Section 7.8. The EUT had its hopping function enabled.

#### Spectrum analyzer settings:

Span = the frequency band of operation

RBW < 30% of the OBW = 300 kHz

VBW  $\geq$  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:

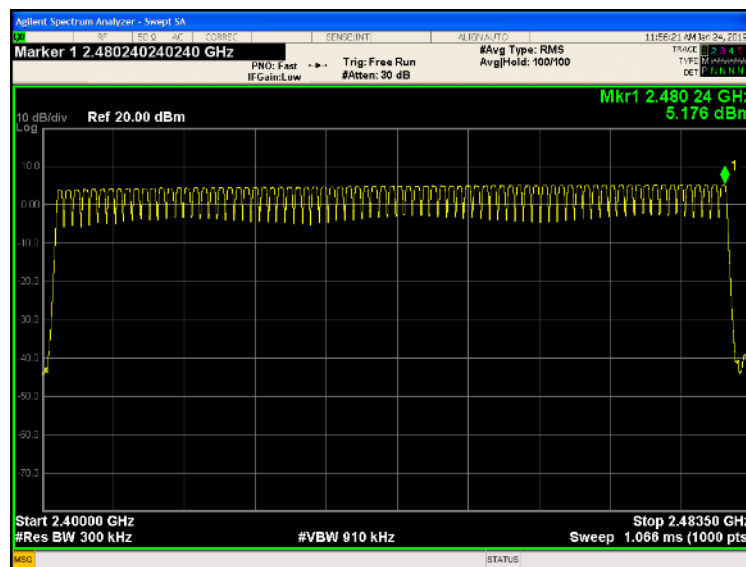


Figure 9-83 Number of Hopping Channels

## 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 ANSI C63.10:2013 American National Standard of Procedure for Compliance Testing of Unlicensed Wireless Devices, Section 7.8. The EUT had its hopping function enabled.

#### **Spectrum analyzer settings:**

Span = zero span, centered on a hopping channel

RBW = 100 kHz

VBW  $\geq 3 \times$  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:

400ms within 31.6s (400ms  $\times$  79 Channels)

### 9.6.4 Test Results:

Pass.

Packet Type	Accumulated Dwell Time in 31.6 s period (ms)	Limit (ms)
1-DH1	374.523	400.000
1-DH3	395.857	400.000
1-DH5	379.264	400.000

## 9.6.5 Test Data:

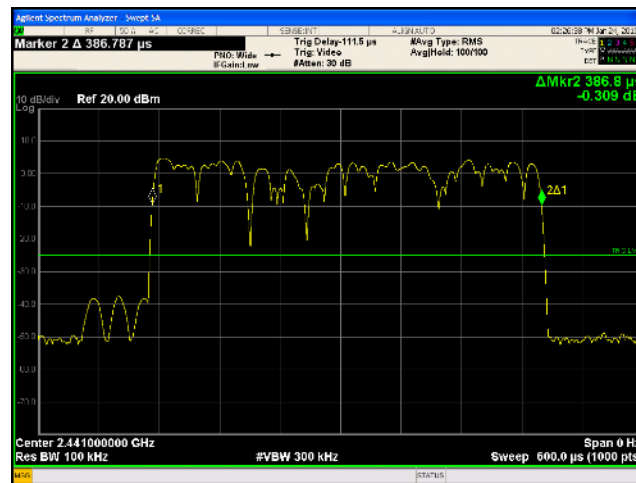


Figure 9-24 Dwell Time – DH1



Figure 9-25 Dwell Time – DH3

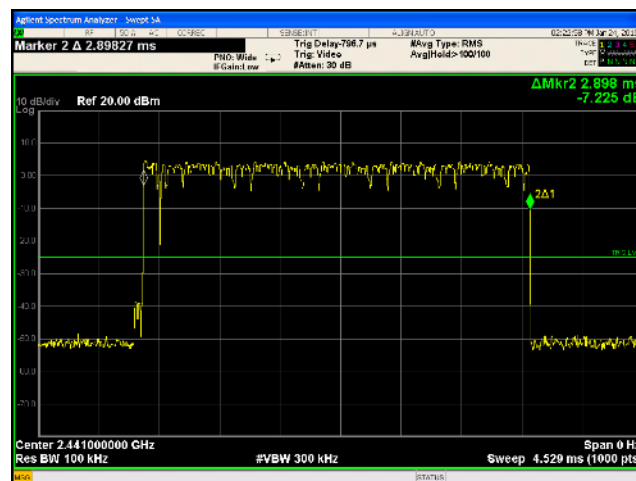


Figure 9-96 Dwell Time - DH5



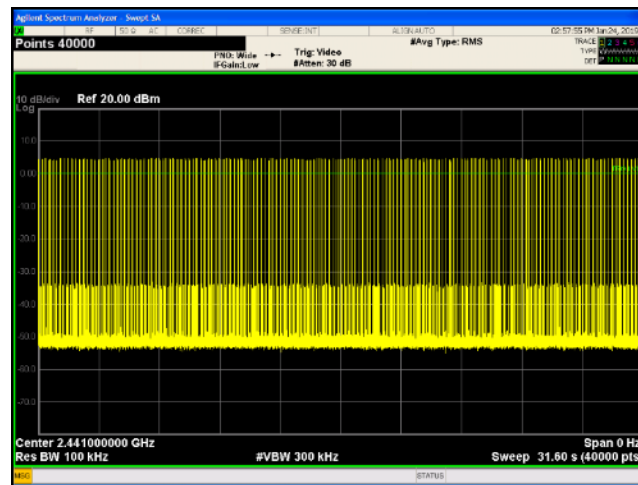


Figure 9-107 Time of Occupancy - DH1

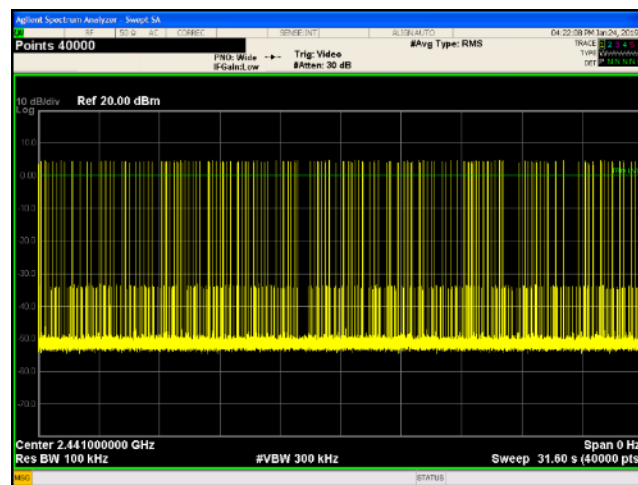


Figure 9-118 Time of Occupancy - DH3

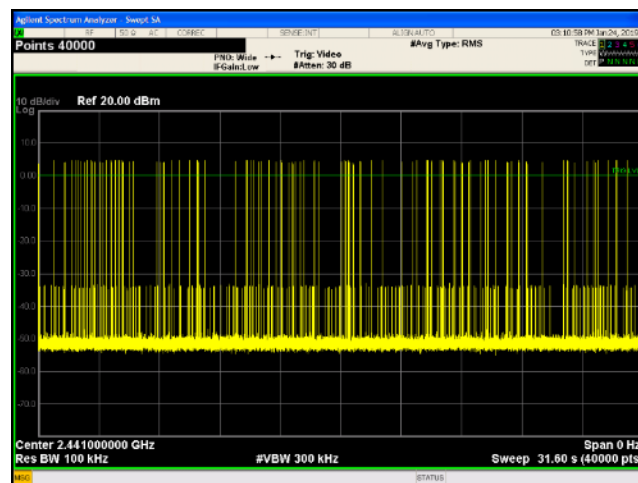


Figure 9-129 Time of Occupancy - DH5

## 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 ANSI C63.10:2013 Section 7.8.

#### **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:

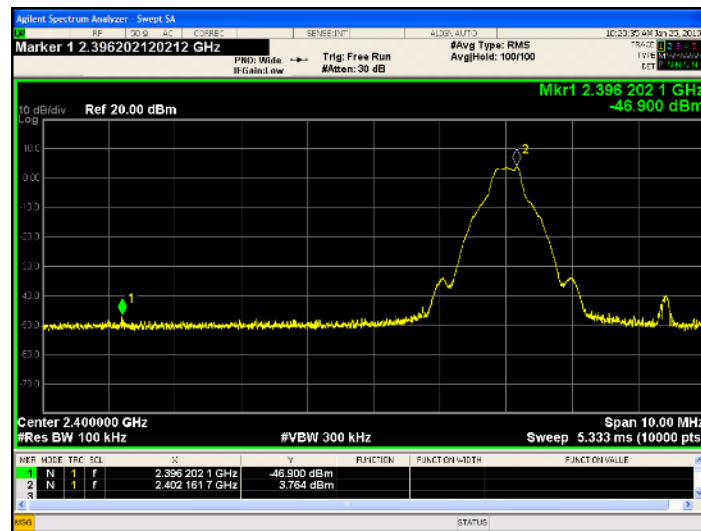


Figure 9-30 Low Channel Band edge: 1-DH5 Mode (Hopping disabled)

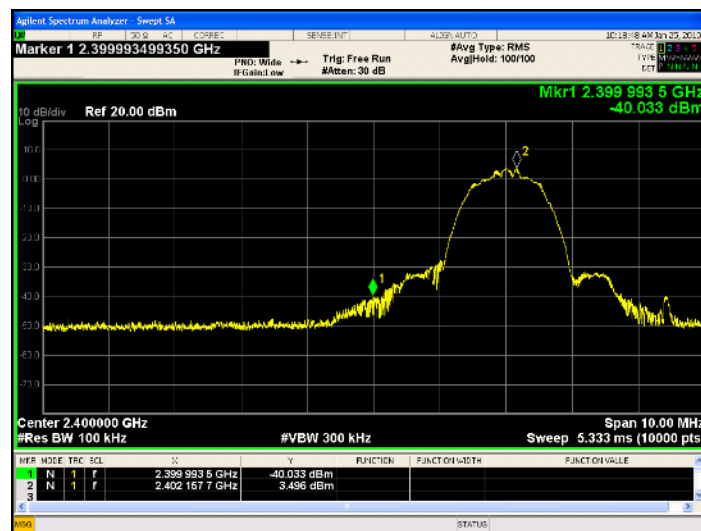


Figure 9-31 Low Channel Band edge: 2-DH5 Mode (Hopping disabled)

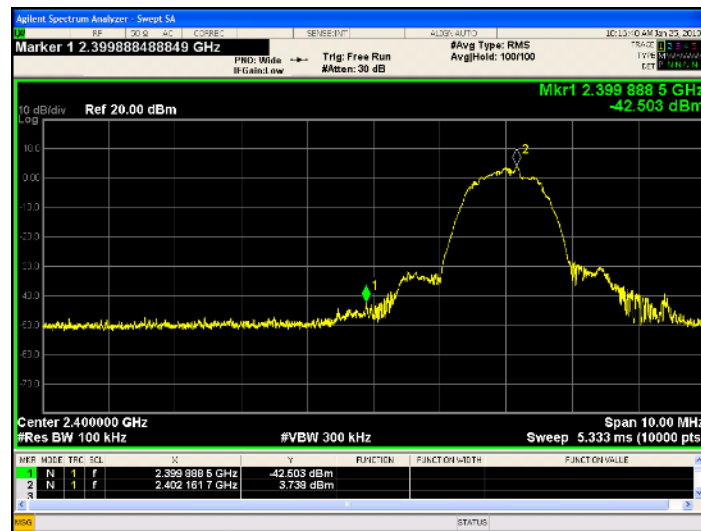


Figure 9-32 Low Channel Band edge: 3-DH5 Mode (Hopping disabled)

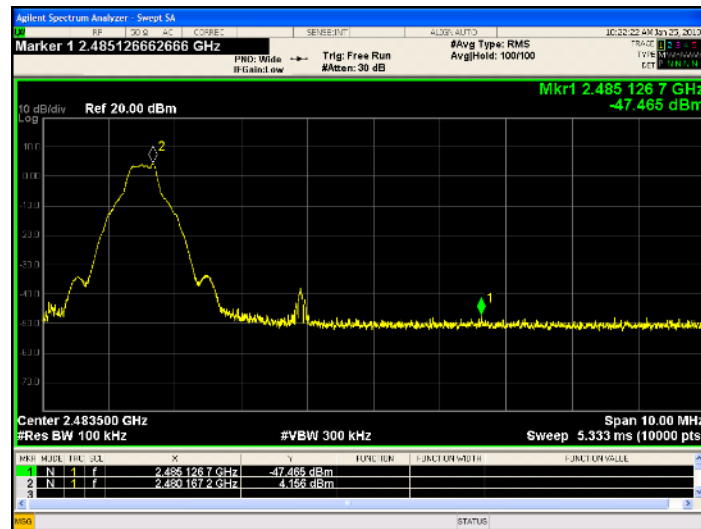


Figure 9-33 High Channel Band edge: 1-DH5 Mode (Hopping disabled)

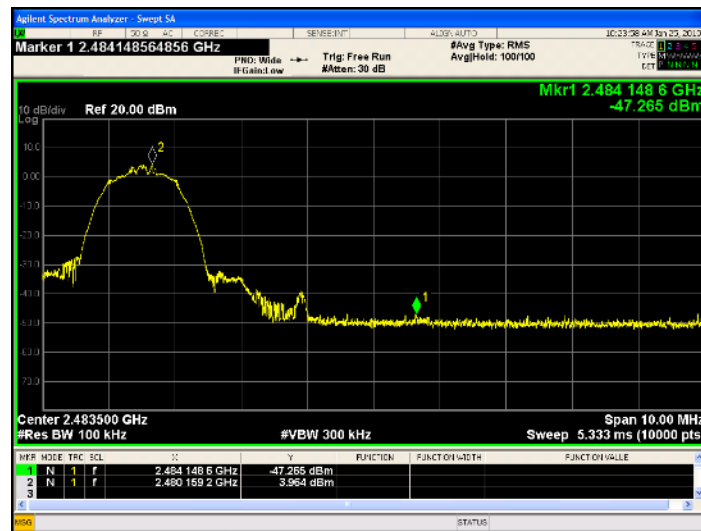


Figure 9-34 High Channel Band edge: 2-DH5 Mode (Hopping disabled)

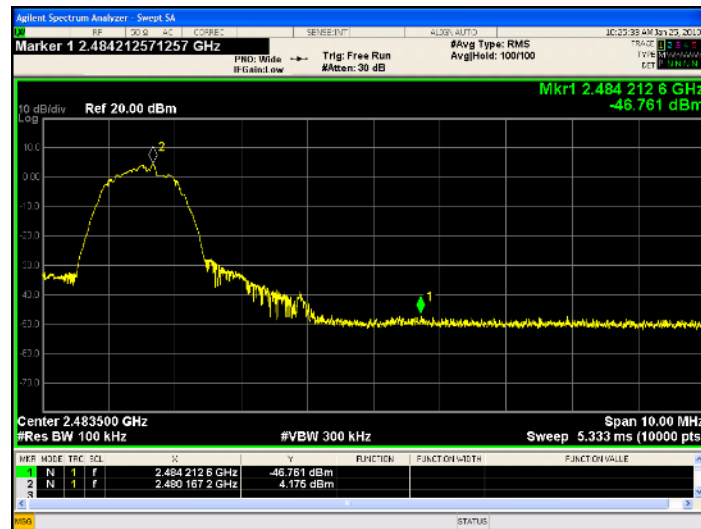


Figure 9-35 High Channel Band edge: 3-DH5 Mode (Hopping disabled)

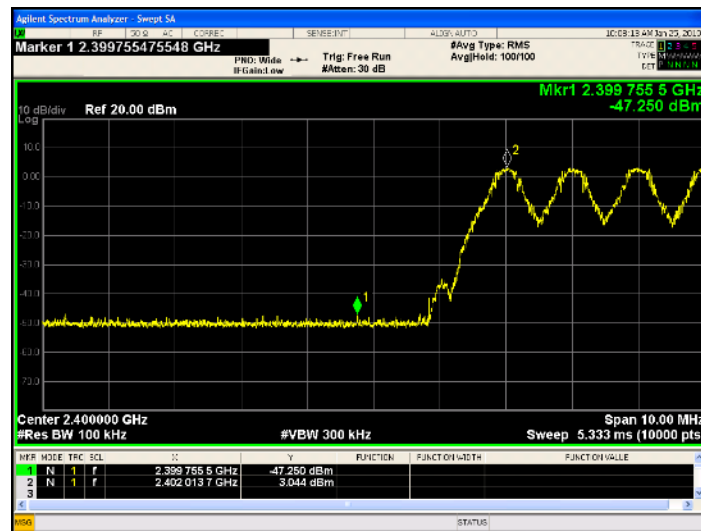


Figure 9-36 Low Channel Band edge 1-DH5 Mode (Hopping enabled)

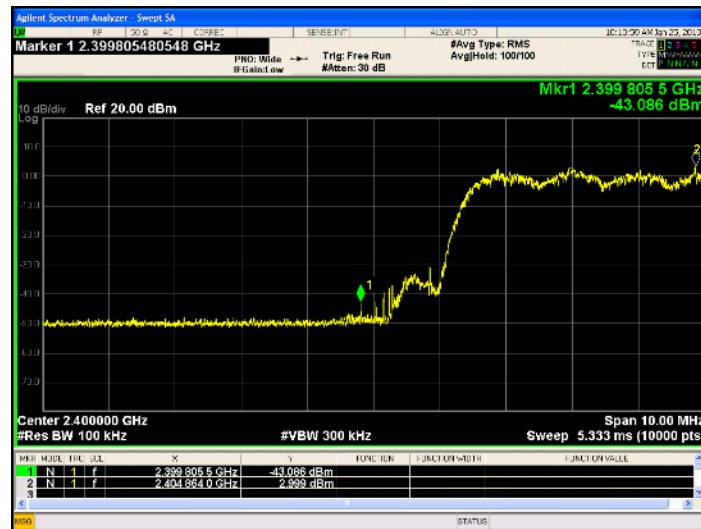


Figure 9-37 Low Channel Band edge 2-DH5 Mode (Hopping enabled)

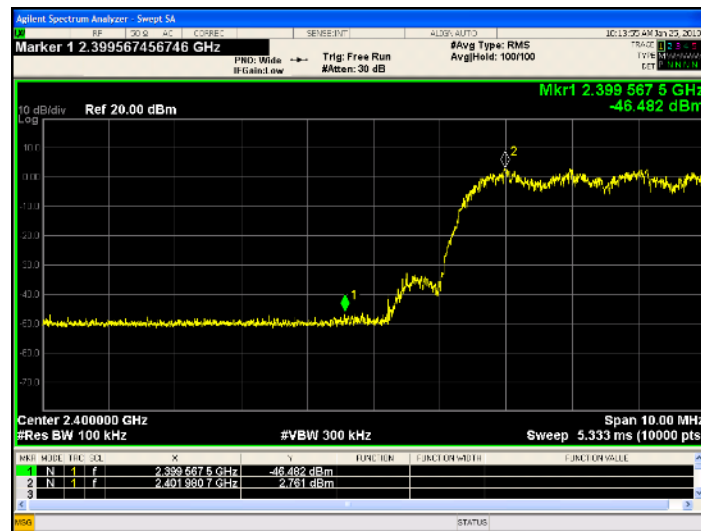


Figure 9-38 Low Channel Band edge 3-DH5 Mode (Hopping enabled)

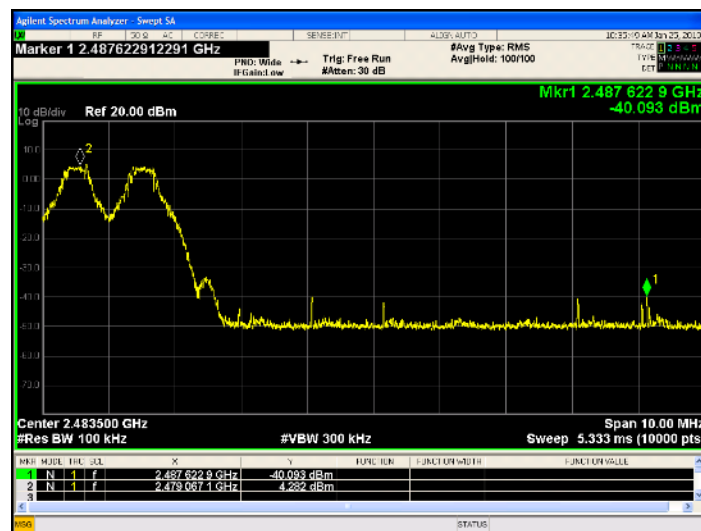


Figure 9-39 High Channel Band 1-DH5 Mode (Hopping enabled)

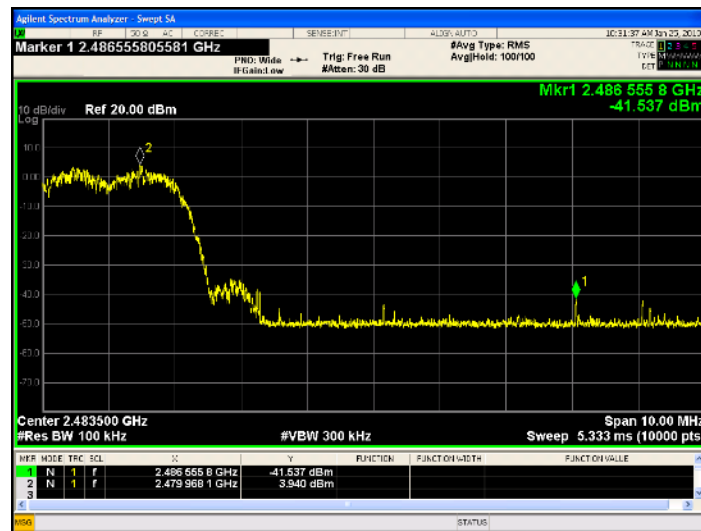


Figure 9-40 High Channel Band 2-DH5 Mode (Hopping enabled)

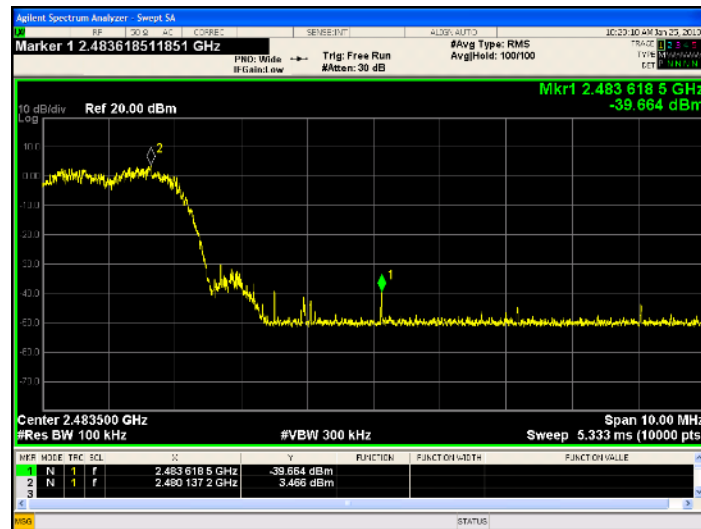


Figure 9-41 High Channel Band 3-DH5 Mode (Hopping enabled)



## 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 ANSI C63.10:2013 Section 7.8.

#### **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:

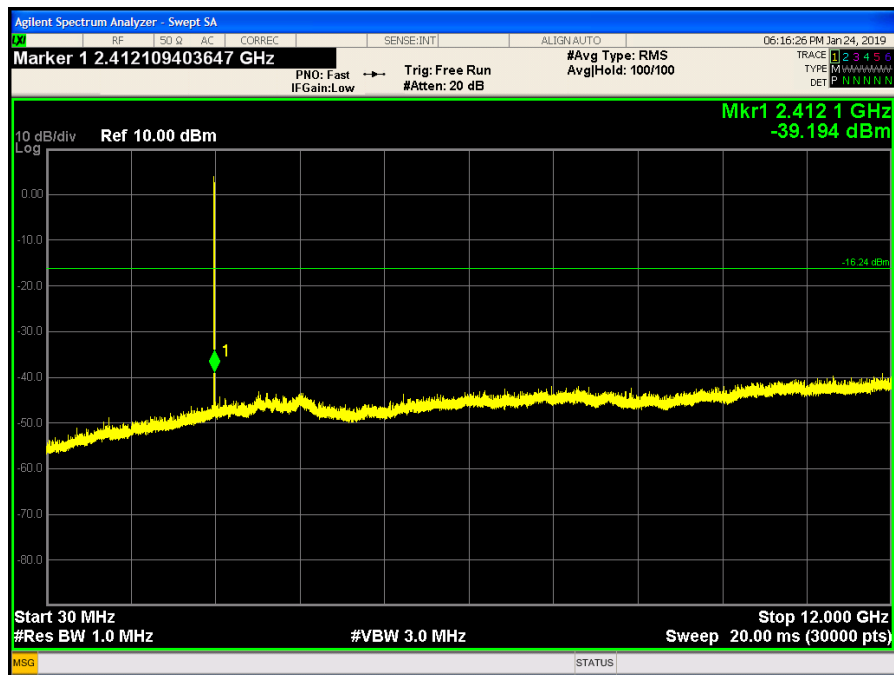


Figure 9-42 Conducted Spurious Emissions 30-12000 MHz: 1-DH5 Mode (Ch. 0)

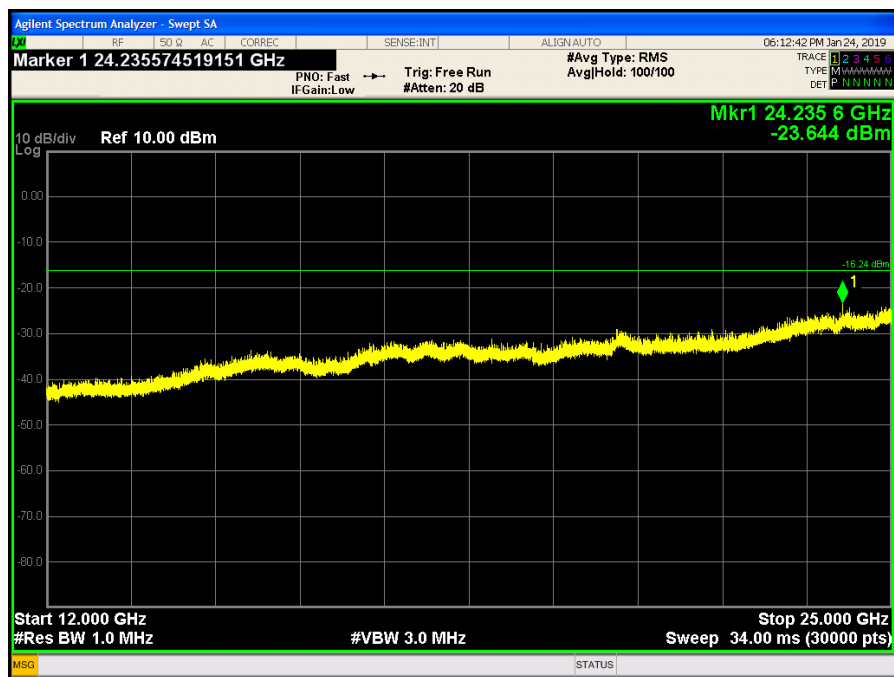


Figure 9-43 Conducted Spurious Emissions 12-25 GHz: 1-DH5 Mode (Ch. 0)

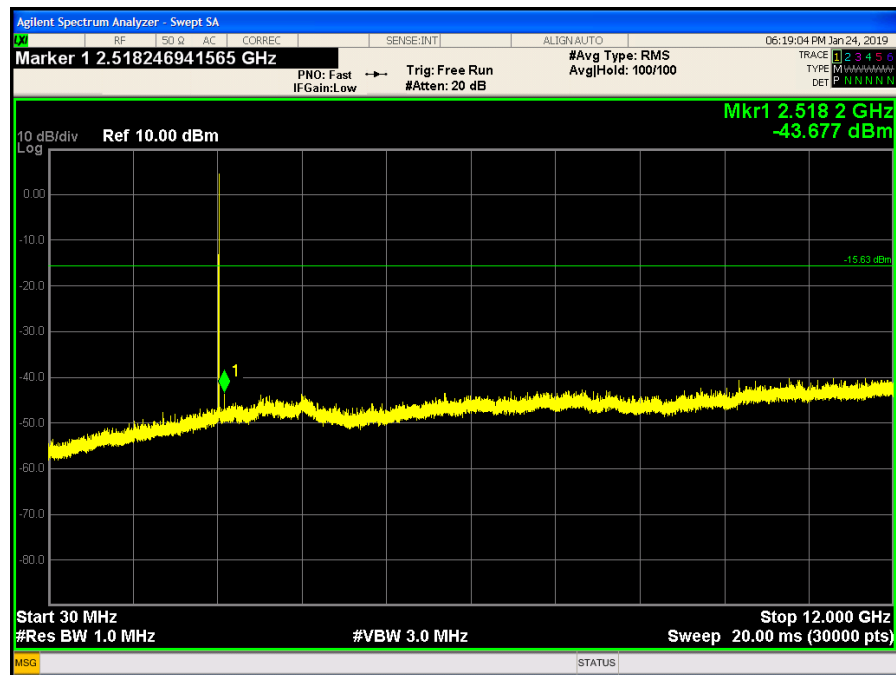


Figure 9-44 Conducted Spurious Emissions 30-12000 MHz: 1-DH5 Mode (Ch. 39)

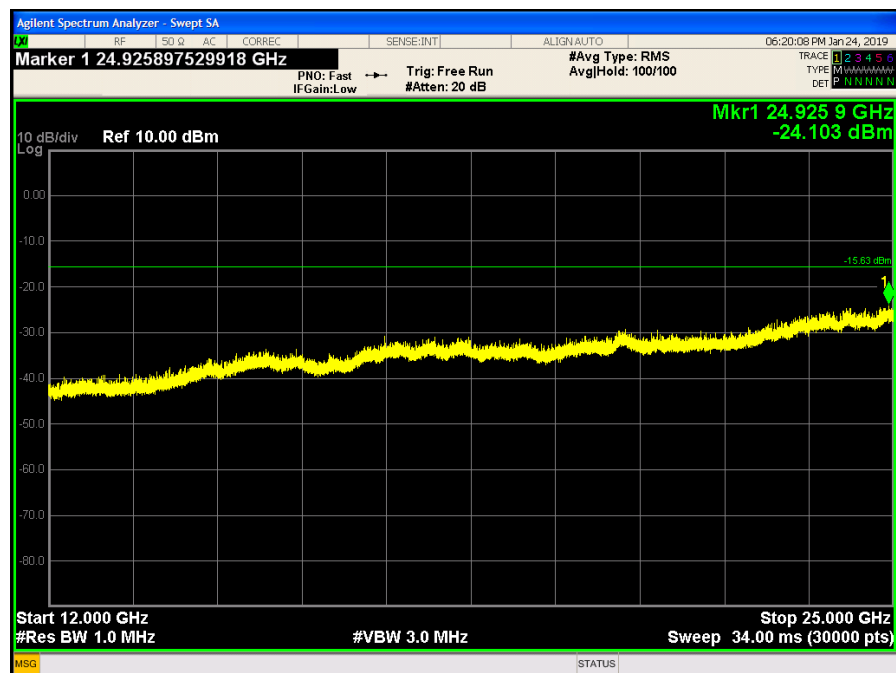


Figure 9-45 Conducted Spurious Emissions 12-25 GHz: 1-DH5 Mode (Ch. 39)

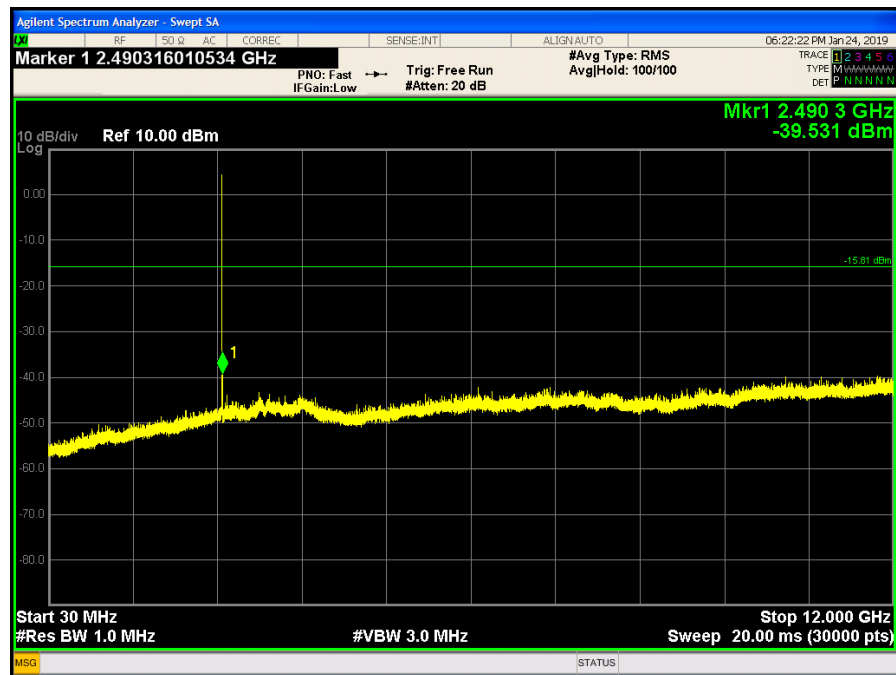


Figure 9-46 Conducted Spurious Emissions 30-12000 MHz: 1-DH5 Mode (Ch. 78)

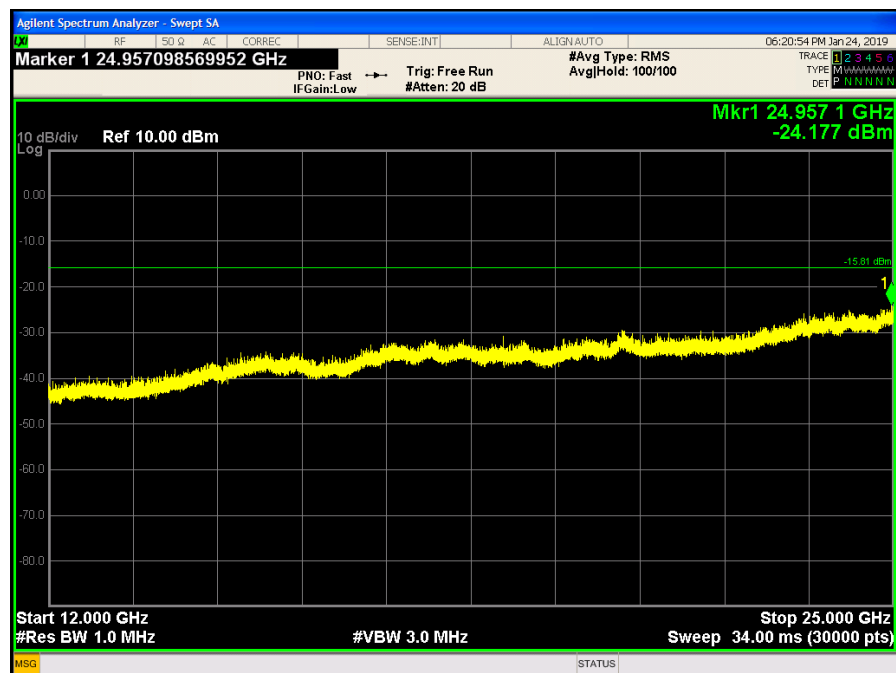


Figure 9-47 Conducted Spurious Emissions 12-25 GHz: 1-DH5 Mode (Ch. 78)

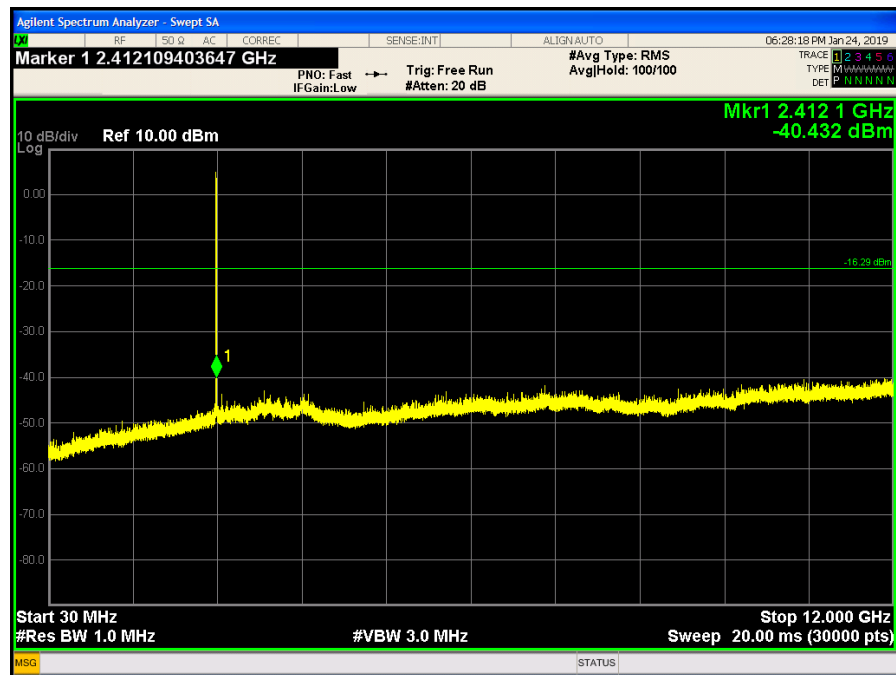


Figure 9-48 Conducted Spurious Emissions 30-12000 MHz: 2-DH5 Mode (Ch. 0)

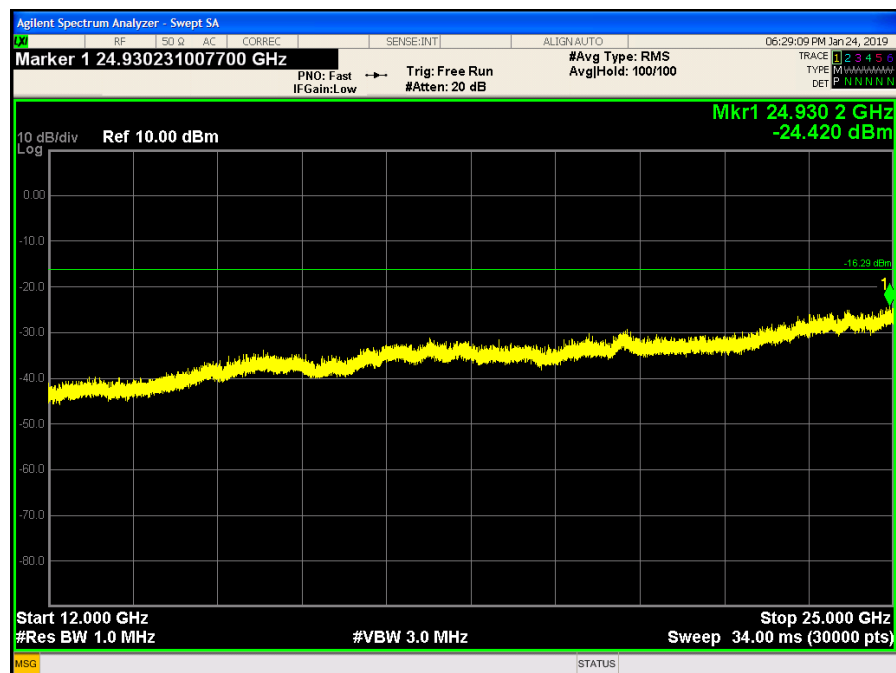


Figure 9-49 Conducted Spurious Emissions 12-25 GHz: 2-DH5 Mode (Ch. 0)

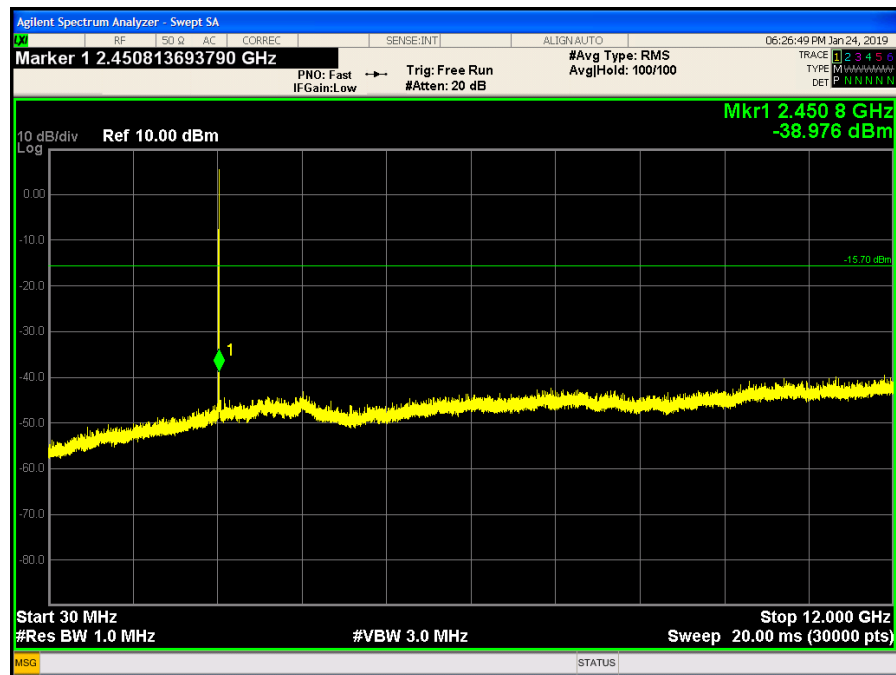


Figure 9-50 Conducted Spurious Emissions 30-12000 MHz: 2-DH5 Mode (Ch. 39)

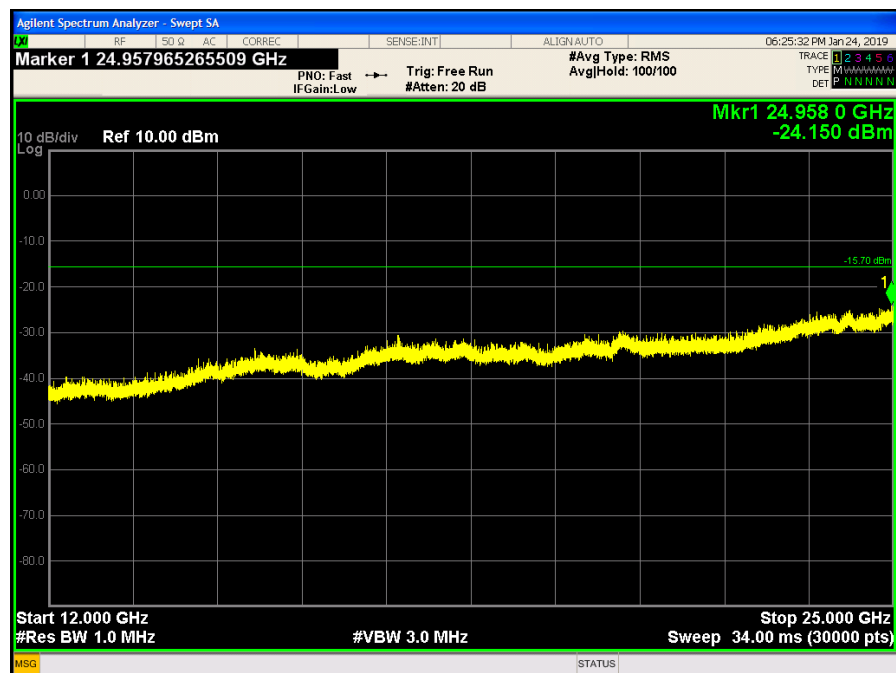


Figure 9-51 Conducted Spurious Emissions 12-25 GHz: 2-DH5 Mode (Ch. 39)

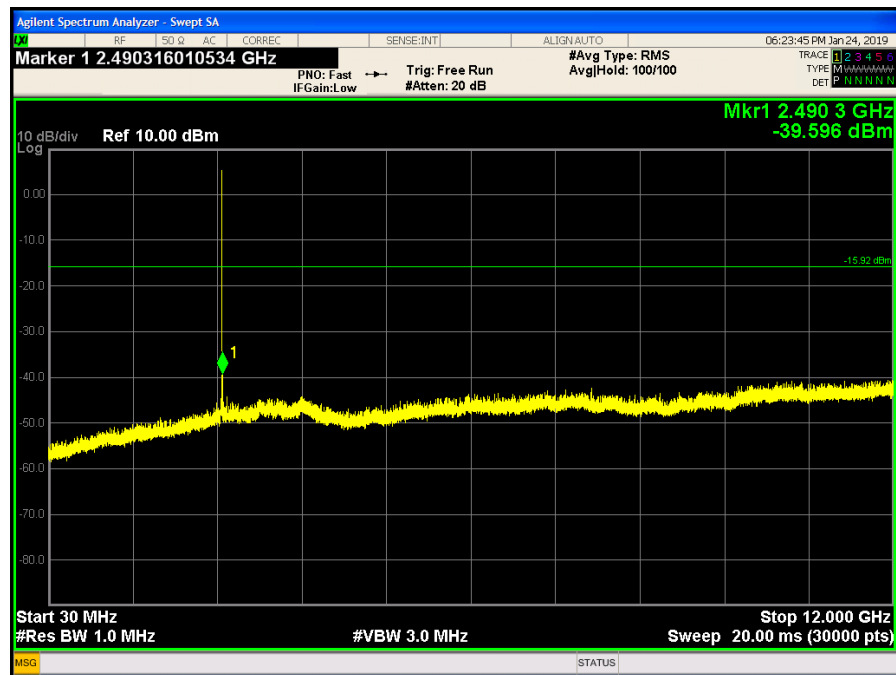


Figure 9-52 Conducted Spurious Emissions 30-12000 MHz: 2-DH5 Mode (Ch. 78)

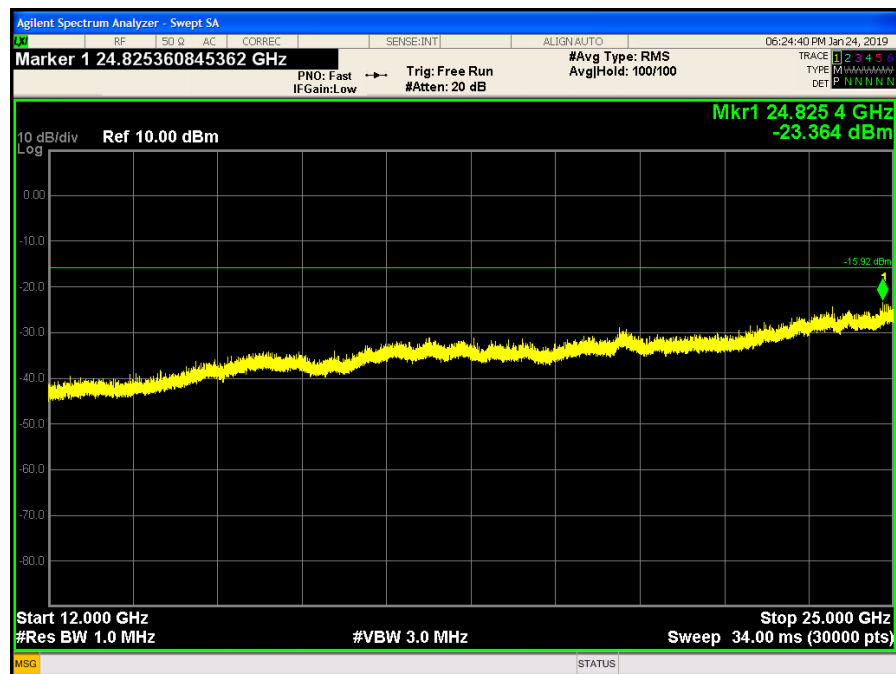


Figure 9-53 Conducted Spurious Emissions 12-25 GHz: 2-DH5 Mode (Ch. 78)

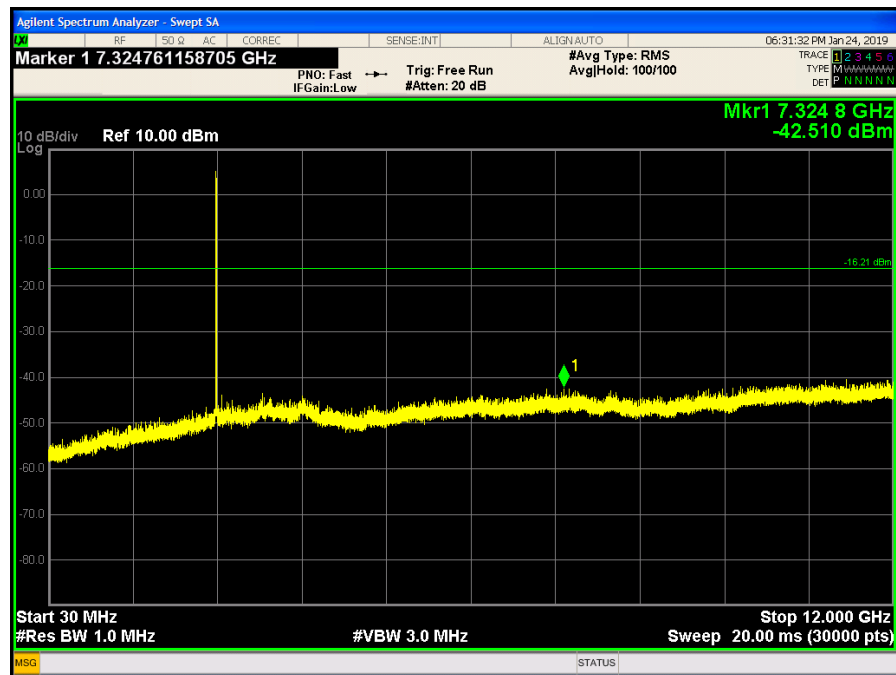


Figure 9-54 Conducted Spurious Emissions 30-12000 MHz: 3-DH5 Mode (Ch. 0)

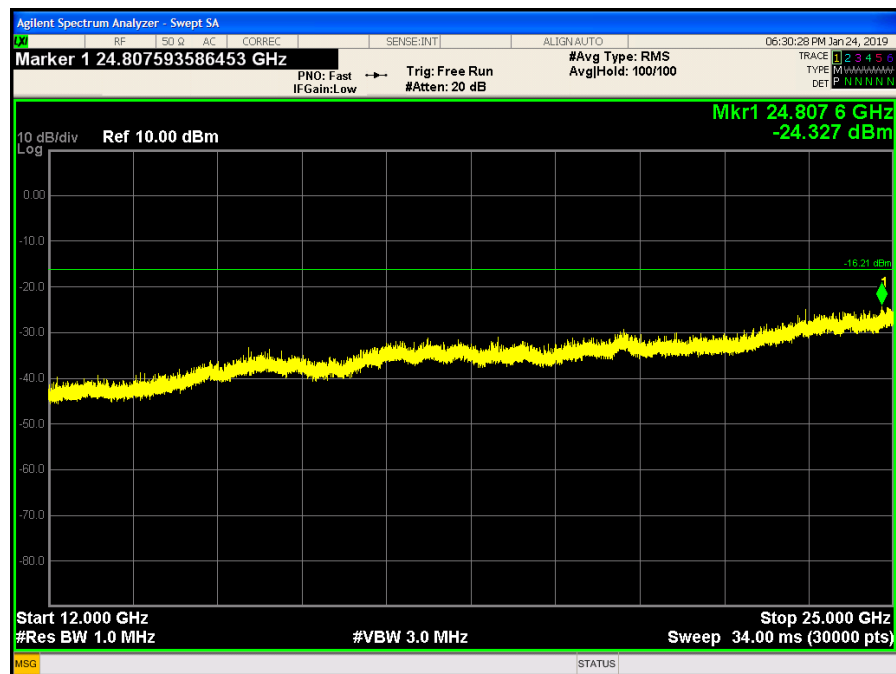


Figure 9-55 Conducted Spurious Emissions 12-25 GHz: 3-DH5 Mode (Ch. 0)



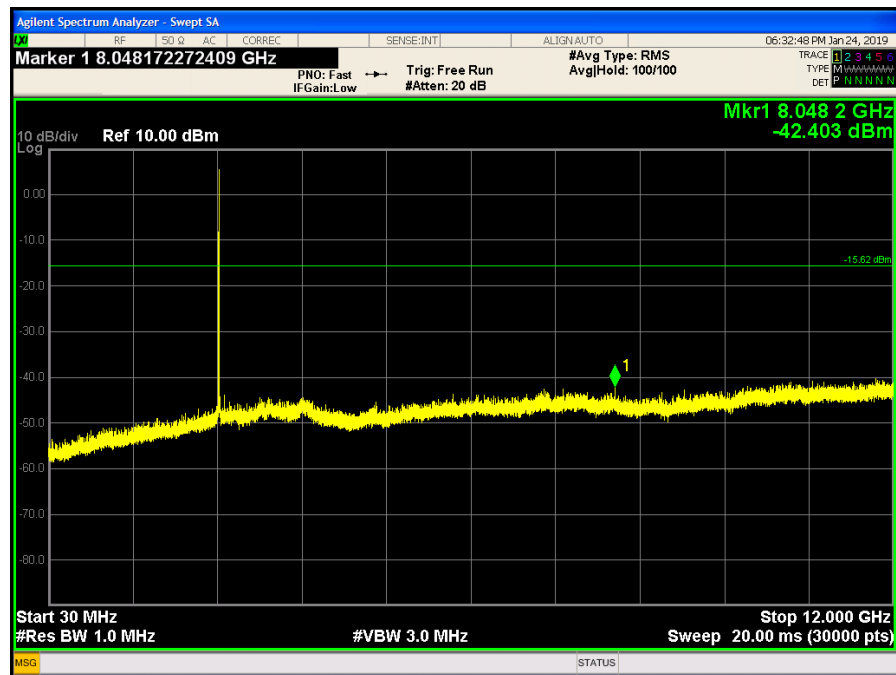


Figure 9-56 Conducted Spurious Emissions 30-12000 MHz: 3-DH5 Mode (Ch. 39)

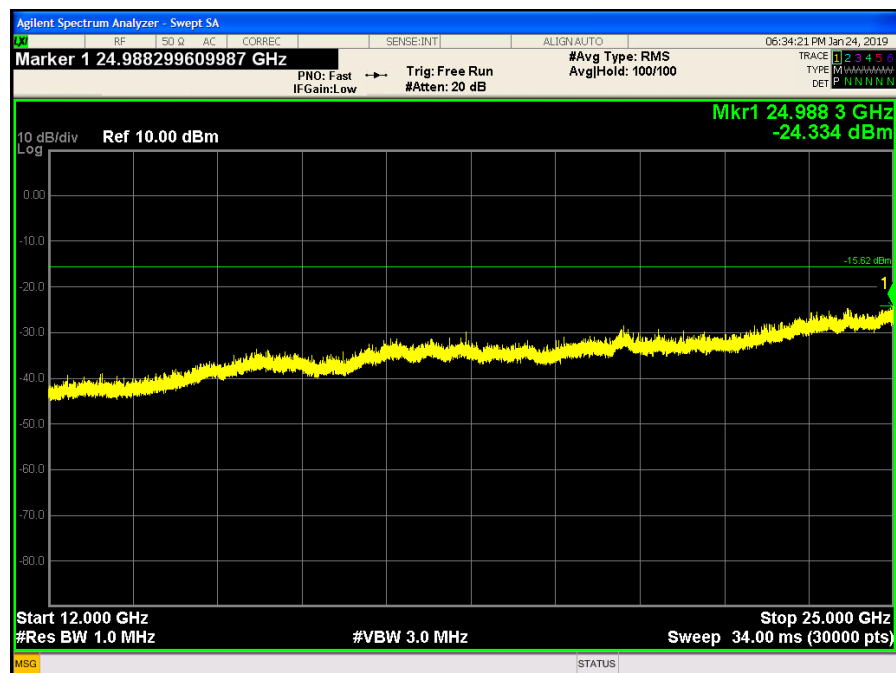


Figure 9-57 Conducted Spurious Emissions 12-25 GHz: 3-DH5 Mode (Ch. 39)

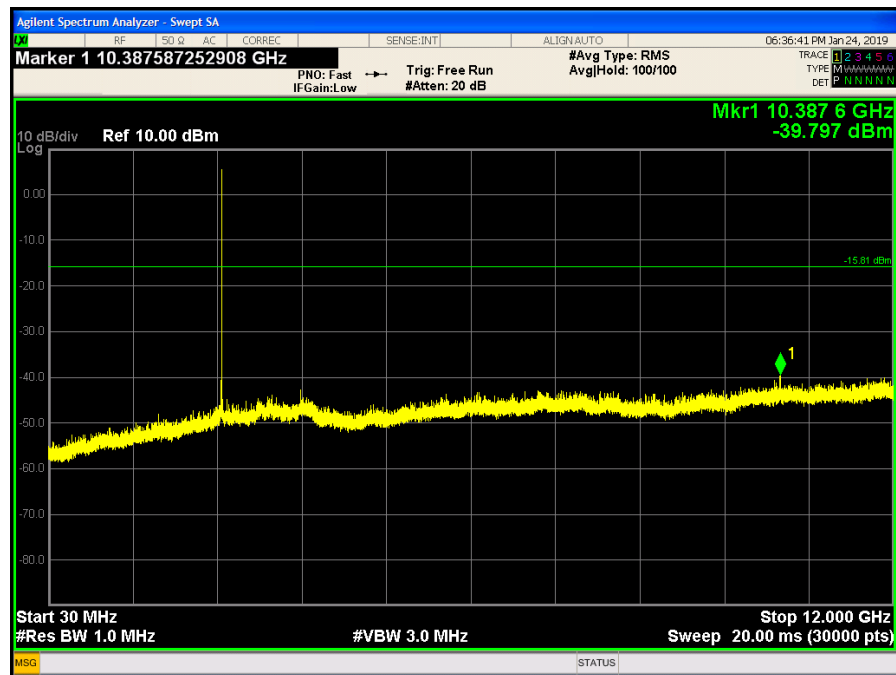


Figure 9-58 Conducted Spurious Emissions 30-12000 MHz: 3-DH5 Mode (Ch. 78)

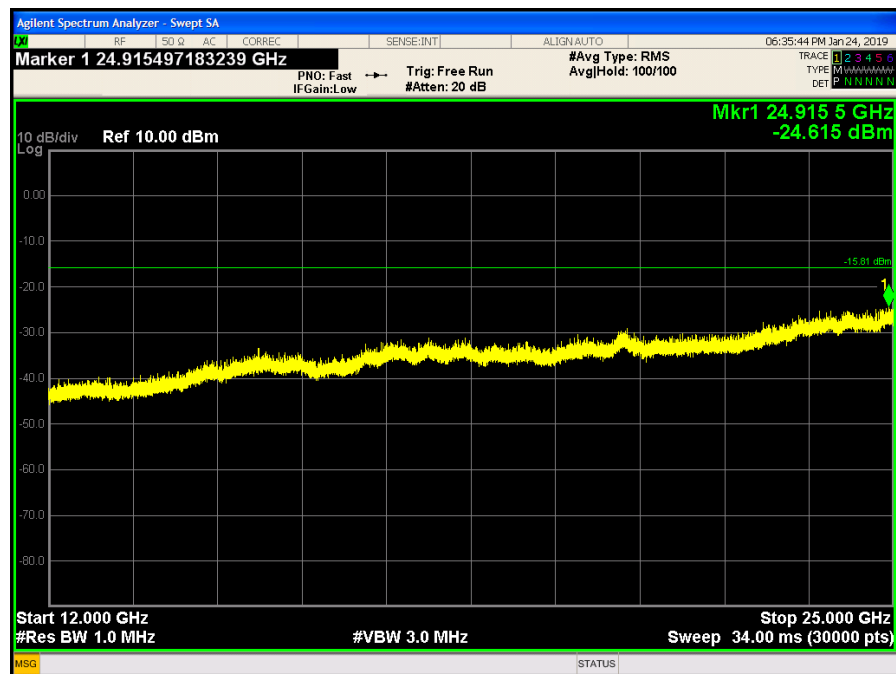


Figure 9-59 Conducted Spurious Emissions 12-25 GHz: 3-DH5 Mode (Ch. 78)

## 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 V05 and ANSI C63.10 2013.

Radiated spurious measurements are made from 9kHz 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 listed in 15.205 and RSS-Gen 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.

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.

Both horizontal and vertical antenna polarizations were investigated. Worst case maximized data is shown in this test report.

**Restricted Band-Edge Emissions****Peak Measurements****Spectrum Analyzer Settings:**

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold)

Span= 2310 – 2500 MHz

Sweep Points = 401

Sweep Time = Auto

**Average Measurements****Spectrum Analyzer Settings:**

RBW= 1 MHz

VBW= 3 kHz

VBW Mode = Linear

Trace Mode: RMS (Average)

Span= 2310 – 2500 MHz

Sweep Points = 401

Sweep Time = Auto

Sweep Count = 200

**Radiated Spurious Emissions****Spectrum Analyzer Settings:*****30 MHz- 1 GHz:***

RBW= 120 kHz

VBW  $\geq 3 \times$  RBW

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

Span= 30 MHz- 1 GHz

Sweep time= Auto

Sweep points  $\geq 2 \times$  Span/RBW***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

Sweep points  $\geq 2 \times$  Span/RBW**Final Measurements above 1 GHz****Peak Measurements****Spectrum Analyzer Settings:**

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold)

Span= wide enough to encompass the emission

Sweep Points  $\geq 2 \times$  Span/RBW

Sweep Time = Auto

**RMS Average Measurements****Spectrum Analyzer Settings:**

RBW= 1 MHz

VBW $\geq$  3  $\times$  RBW

Detector= RMS

Span= wide enough to encompass the emission

Sweep points $\geq$  2  $\times$  Span/RBW

Sweep time = auto

Trace= Average at least 100 traces

Trace Averaging Type= power (RMS)

The duty cycle correction factor is added to the emission level.

**Sample Calculation:**

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

### 9.9.3 Limits:

Frequency (MHz)	Field Strength ( $\mu\text{V/m}$ )	Measurement Distance (meters)	Corrected Field Strength for 3m measurement distance ( $\text{dB}\mu\text{V/m}$ )
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 (Restricted Frequency Bands)	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

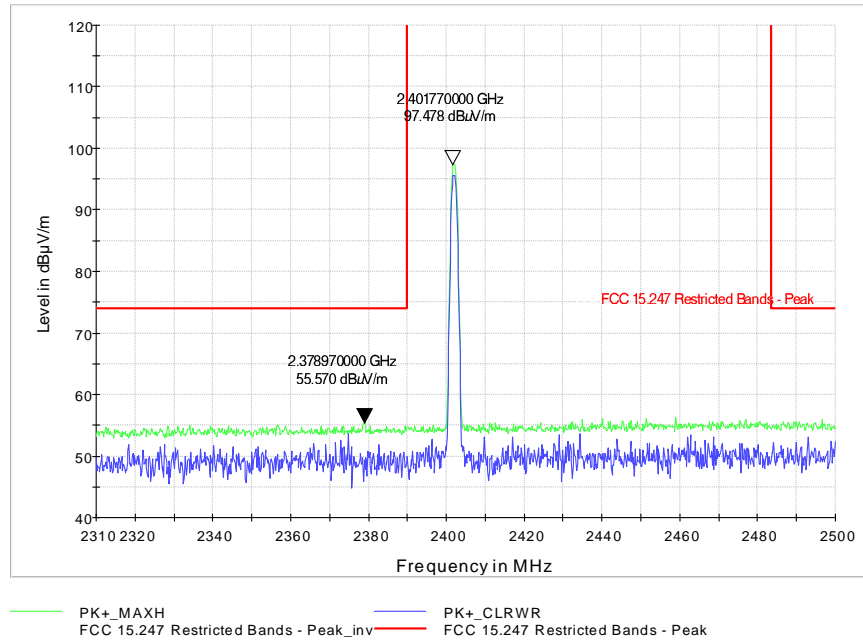
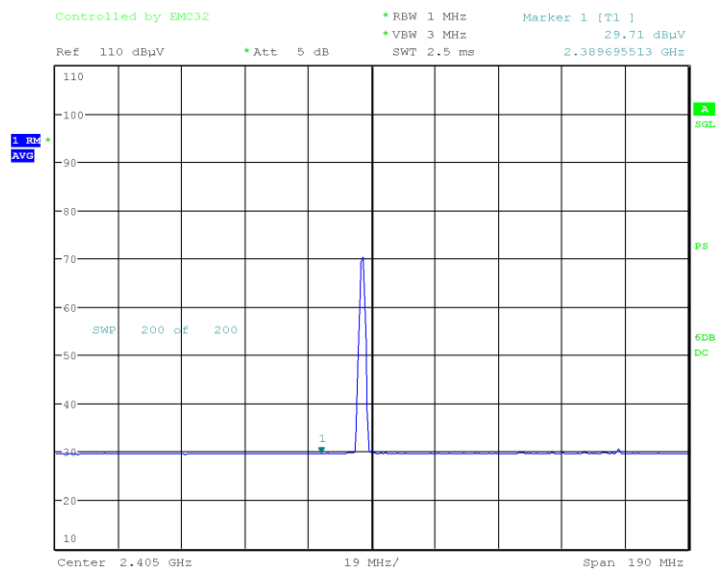


Figure 9-60 Restricted Band Edge 1-DH5 Mode- Ch. 0 (2310-2390MHz) – Peak



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Figure 9-61 Restricted Band Edge 1-DH5 Mode- Ch. 0 (2310-2390MHz) – Average

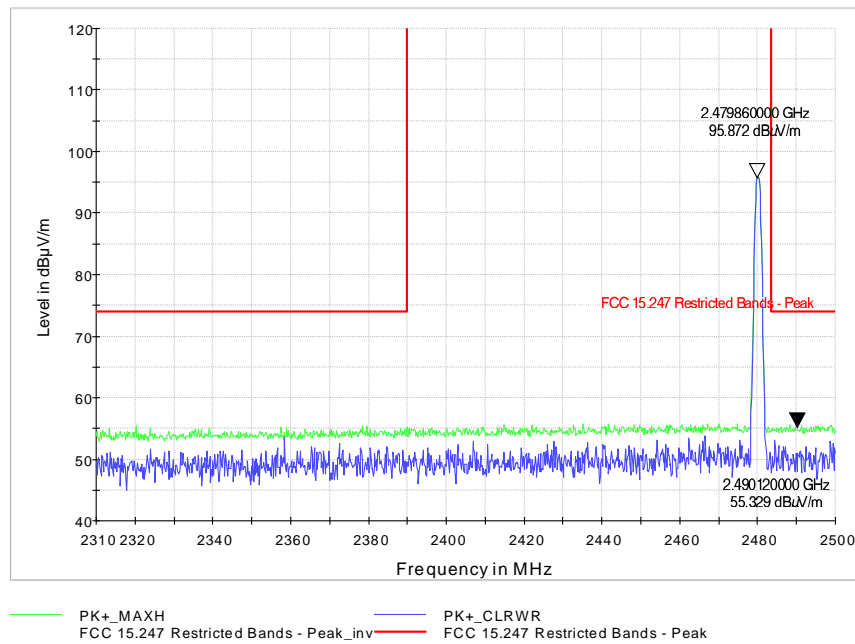
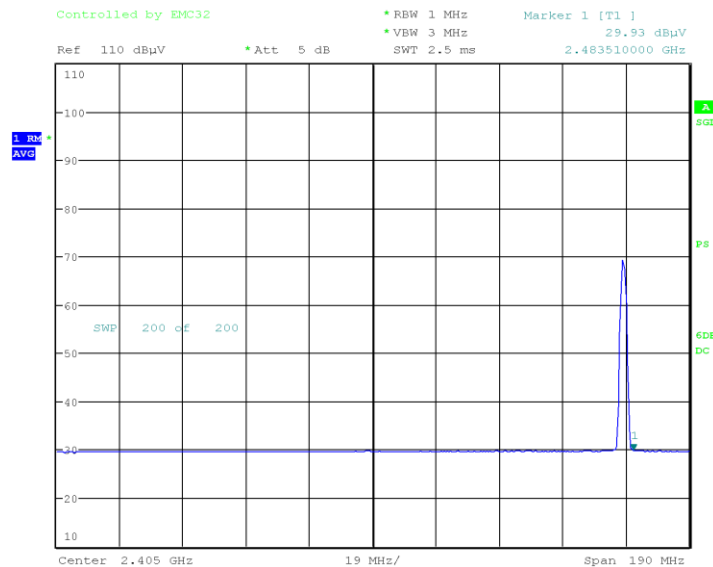


Figure 9-62 Restricted Band Edge 1-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Peak



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Figure 9-63 Restricted Band Edge 1-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Average



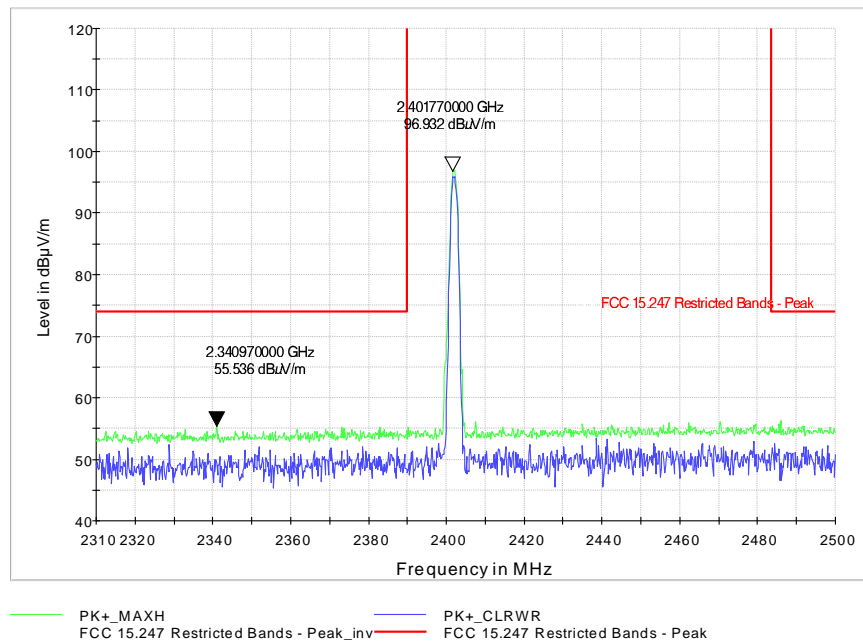
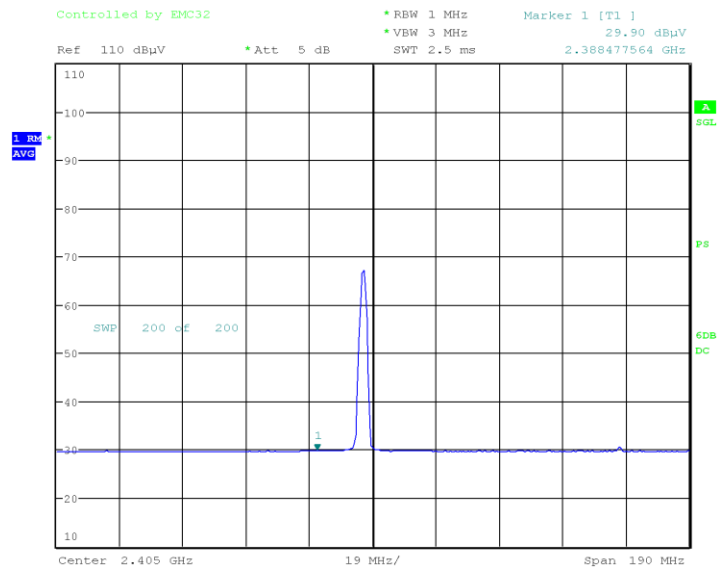
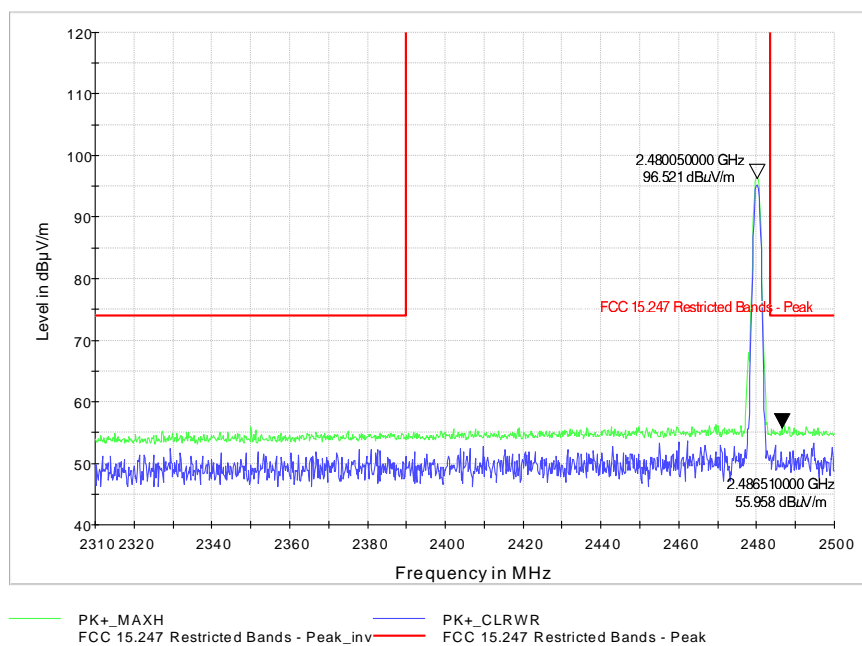


Figure 9-64 Restricted Band Edge 2-DH5 Mode- Ch. 0 (2310-2390MHz) – Peak

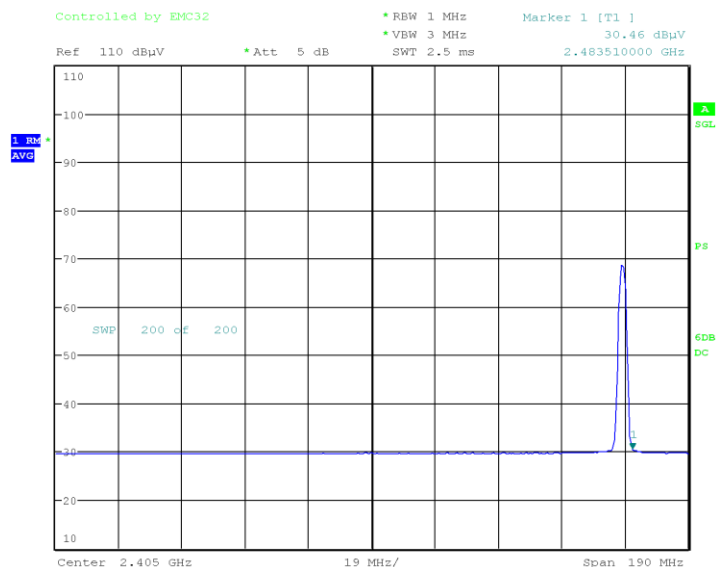


Date: 13.APR.2019 17:41:28

Figure 9-65 Restricted Band Edge 2-DH5 Mode- Ch. 0 (2310-2390MHz) - Average



**Figure 9-66 Restricted Band Edge 2-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Peak**



Date: 13.APR.2019 17:05:16

**Figure 9-67 Restricted Band Edge 2-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Average**

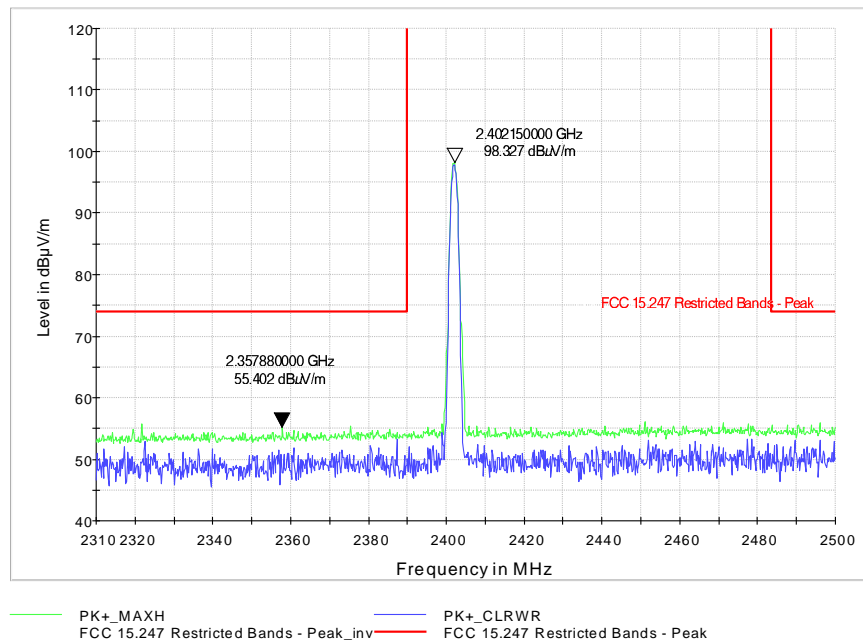
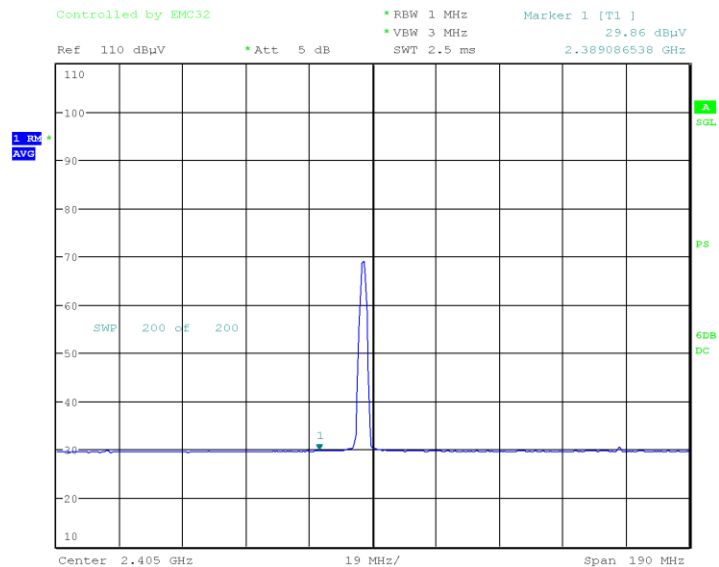


Figure 9-68 Restricted Band Edge 3-DH5 Mode– Ch. 0 (2310-2390MHz) – Peak



Date: 13.APR.2019 17:48:19

Figure 9-69 Restricted Band Edge 3-DH5 Mode– Ch. 0 (2310-2390MHz) - Average

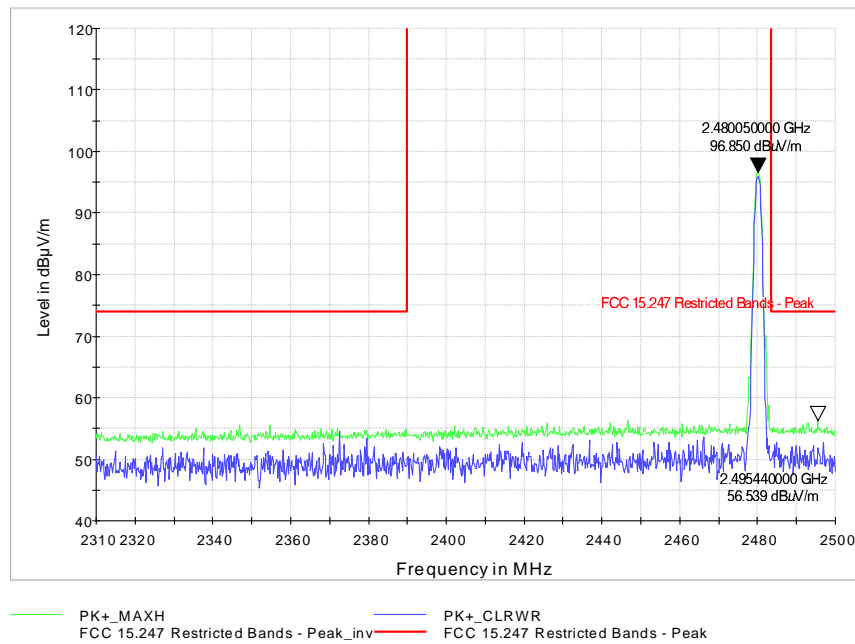
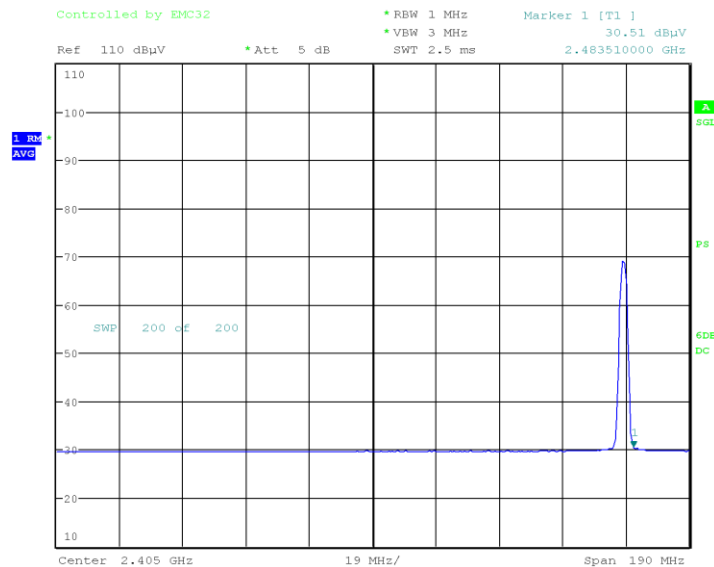


Figure 9-70 Restricted Band Edge 3-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Peak



Date: 13.APR.2019 16:53:46

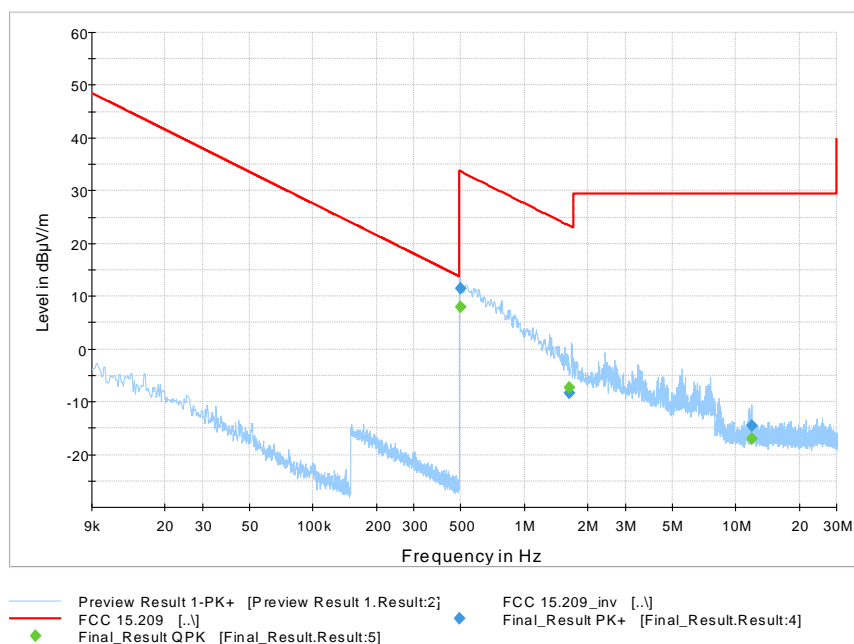
Figure 9-71 Restricted Band Edge 3-DH5 Mode– Ch. 78 (2483.5-2500MHz) – Average

Band edge Average Data							
Carrier Frequency (MHz)	Spurious Frequency (MHz)	Raw Avg. Amplitude (dBμV)	System Correction Factor (dB)	Duty cycle correction factor(dB)	Corrected Avg. Field Strength (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)
1-DH5							
2402	2389.69	29.71	12.8	1.17	43.68	54	-10.32
2480	2483.51	29.93	13.2	1.17	44.30	54	-9.70
2-DH5							
2402	2388.47	29.9	12.8	1.14	43.84	54	-10.16
2480	2483.51	30.46	13.2	1.14	44.80	54	-9.20
3-DH5							
2402	2389.08	29.86	12.8	1.15	43.81	54	-10.19
2480	2483.51	30.51	13.2	1.15	44.86	54	-9.14

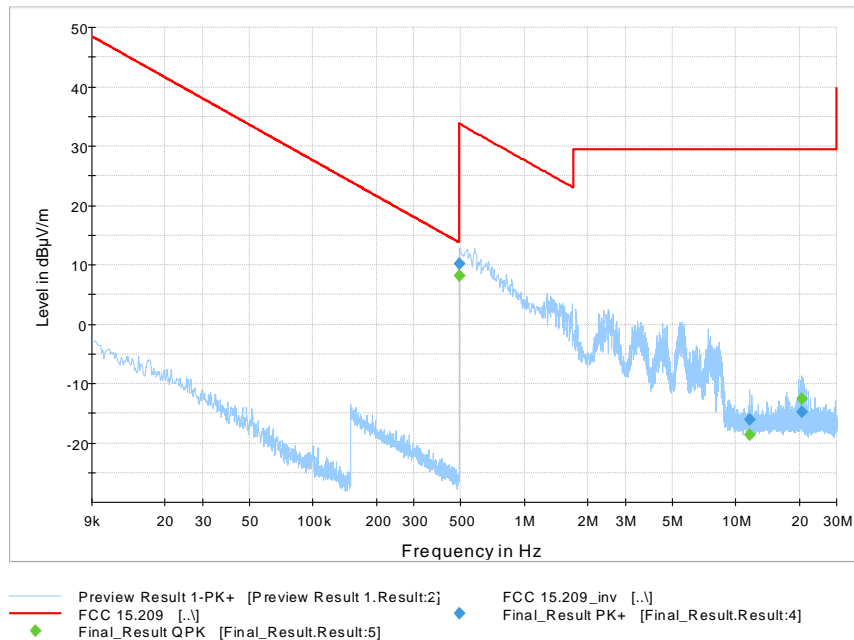
#### 9.9.5.2 Emissions in 9KHz- 30MHz range

All channels and modes of operations were tested and worst-case emissions in 2DH5 mode, Ch 39 is shown below

RSE 9KHz – 30MHz							
Carrier Frequency (MHz)	Loop orientation	Emission Frequency (MHz)	Raw Quasi-Peak Amplitude (dBμV/m)	Correction Factor (dB)	Corrected Quasi-Peak Field Strength (dBμV/m)	Quasi-Peak Limit (dBμV/m)	Quasi-Peak Margin (dB)
2441	Parallel	0.498	-4.23	12.30	8.07	33.66	-25.59
2441	Parallel	1.638	-10.50	3.30	-7.20	23.32	-30.52
2441	Parallel	11.892	-11.91	-5.00	-16.91	29.54	-46.45
2441	Perpendicular	0.494	-4.06	12.30	8.24	33.73	-25.49
2441	Perpendicular	11.649	-13.55	-5.00	-18.55	29.54	-48.09
2441	Perpendicular	20.521	-6.89	-5.60	-12.49	29.54	-42.03



**Plot 9-72. Radiated Spurious Emissions (Ch. 39) 2-DH5 (9KHz – 30MHz)**  
**Parallel orientation**

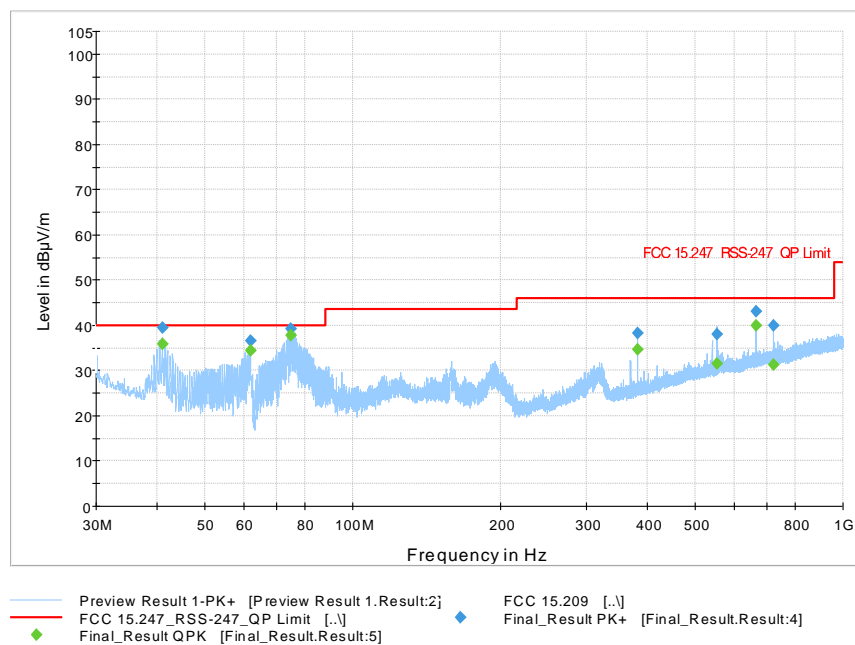


**Plot 9-73. Radiated Spurious Emissions (Ch. 39) 2-DH5 (9KHz – 30MHz)**  
**Perpendicular orientation**

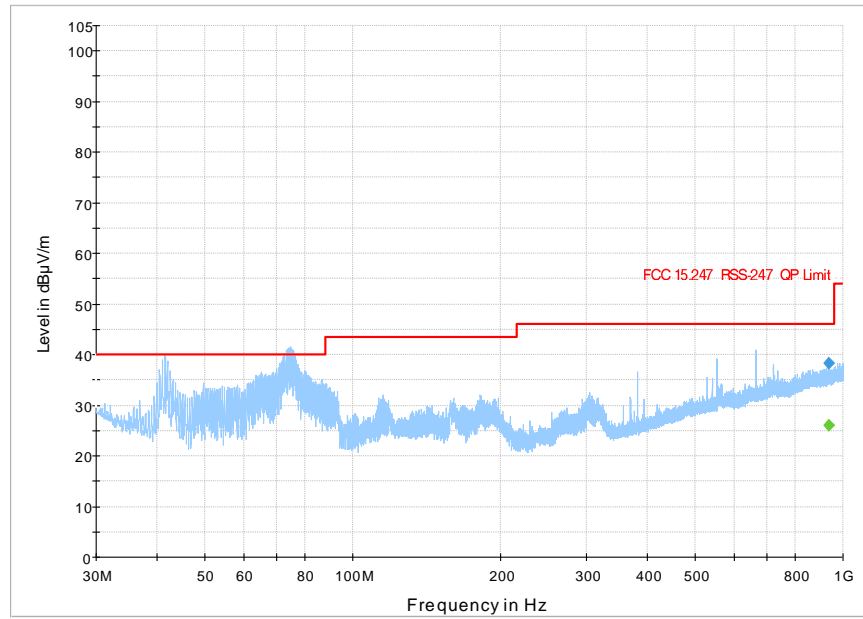
### 9.9.5.3 Emissions in 30 MHz- 1 GHz range

All channels and modes of operations were tested and worst-case emissions in 2DH5 mode, Ch 39 is 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)
2441	934.764	-7.19	33.2	26.01	46.02	-20.01



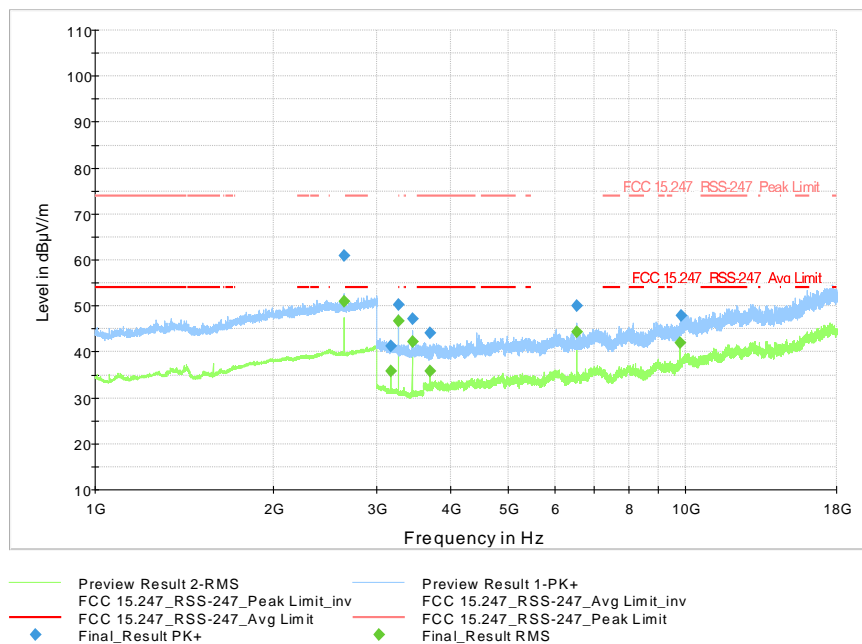
**Plot 9-74. Radiated Spurious Emissions (30MHz - 1GHz) – Ambient – Radio OFF – Digital Transmissions**



**Plot 9-75. Radiated Spurious Emissions (Ch. 39) 2-DH5 (30MHz - 1GHz)**



### 9.9.5.4 Emissions in 1-18 GHz range



**Figure 9-76 Radiated Spurious Emissions (1-18 GHz) – Ambient – Radio OFF – Digital Transmissions**

RSE 1 - 18GHz Average Data 1-DH5							
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dBμV)	System Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)
2402	17567.40	20.28	24.0	0	44.28	54	-9.72
2441	17580.50	20.16	24.1	0	44.26	54	-9.74
2480	17949.60	19.39	24.4	0	43.79	54	-10.21

RSE 1 - 18GHz Peak Data 1-DH5						
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	17847.30	30.53	24.0	54.53	74	-19.47
2441	17193.20	31.97	23.0	54.97	74	-19.03
2480	17972.50	31.00	24.4	55.40	74	-18.60

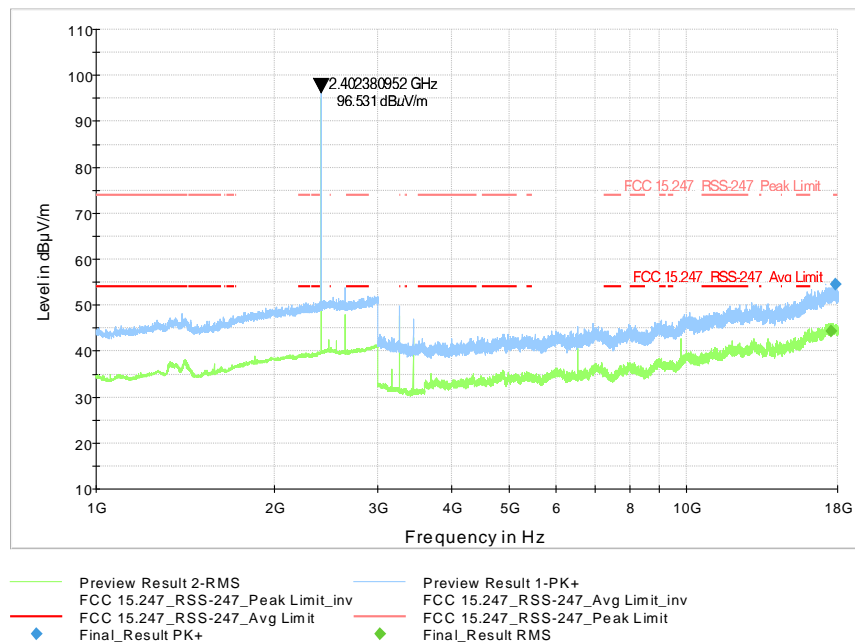


Figure 9-77 Radiated Spurious Emissions (Ch. 0) 1-DH5 (1-18 GHz)

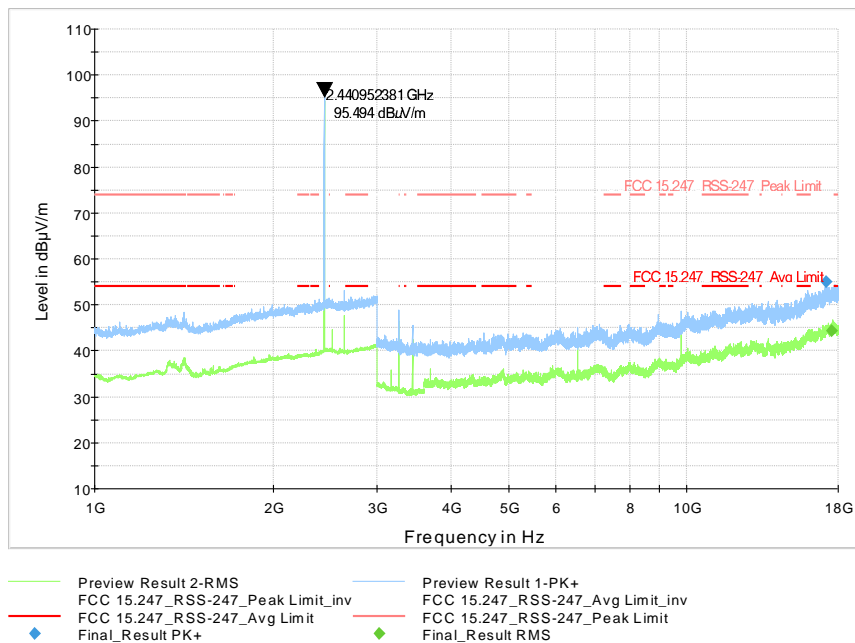


Figure 9-78 Radiated Spurious Emissions (Ch. 39) 1-DH5 (1-18 GHz)

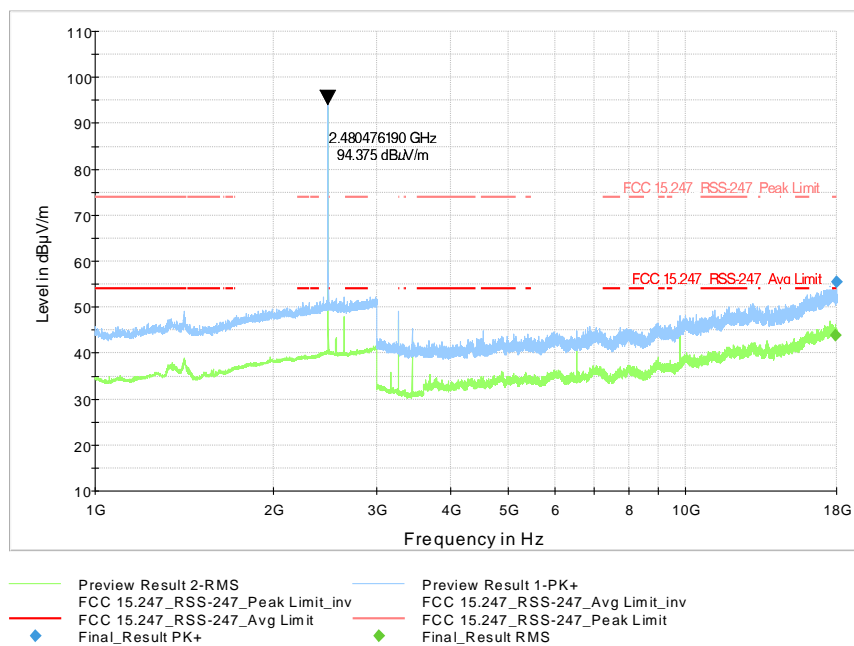
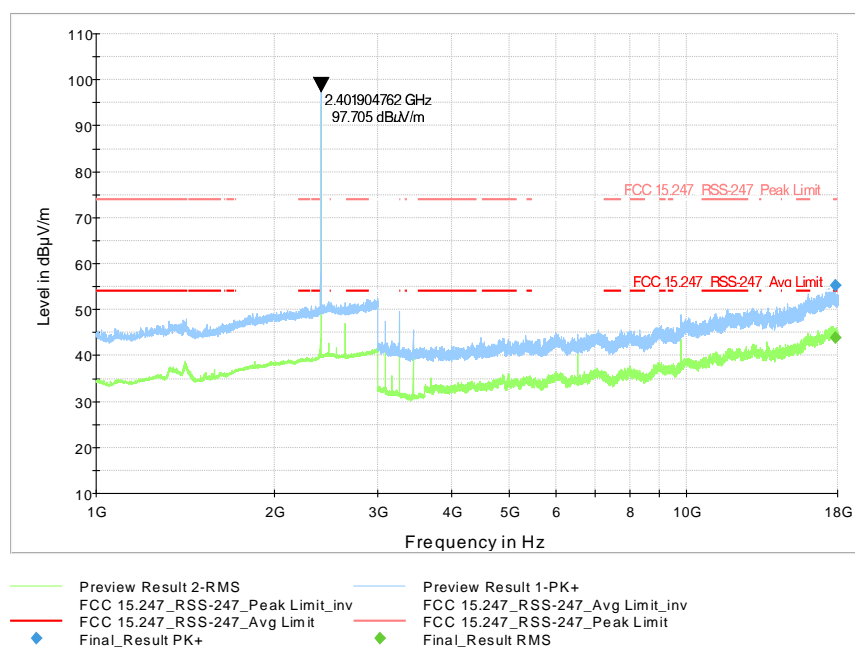


Figure 9-79 Radiated Spurious Emissions (Ch. 78) 1-DH5 (1-18 GHz)

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	17871.80	19.62	24.3	0	43.92	54	-10.08
2441	17867.80	19.69	24.2	0	43.89	54	-10.11
2480	17844.00	19.78	23.9	0	43.68	54	-10.32

RSE 1 - 18GHz Peak Data 2-DH5						
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	17851.60	31.18	24.0	55.18	74	-18.82
2441	17869.80	31.41	24.2	55.61	74	-18.39
2480	17803.60	31.12	23.9	55.02	74	-18.98



**Figure 9-80 Radiated Spurious Emissions (Ch. 0) 2-DH5 (1-18 GHz)**

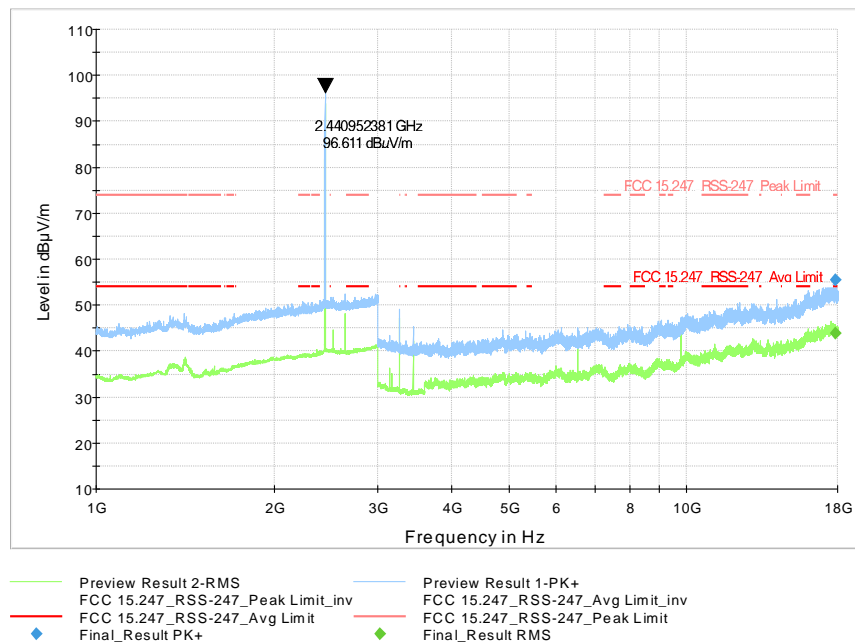


Figure 9-81 Radiated Spurious Emissions (Ch. 39) 2-DH5 (1-18 GHz)

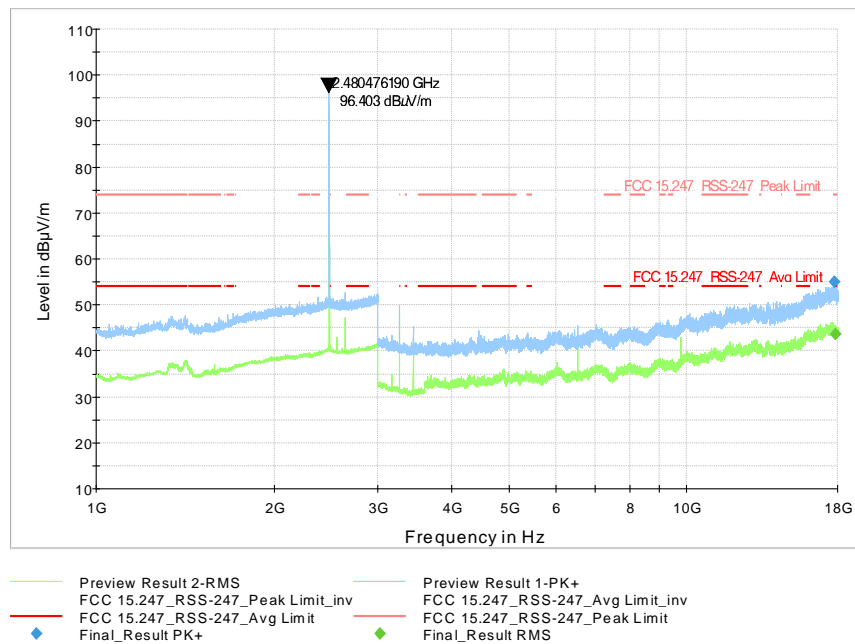


Figure 9-82 Radiated Spurious Emissions (Ch. 78) 2-DH5 (1-18 GHz)

RSE 1 - 18GHz Average Data 3-DH5							
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	17795.50	20.02	23.5	0	43.52	54	-10.48
2441	17882.20	19.59	24.5	0	44.09	54	-9.91
2480	17889.20	19.67	24.5	0	44.17	54	-9.83

RSE 1 - 18GHz Peak Data 3-DH5						
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	17756.70	30.71	23.4	54.11	74	-19.89
2441	17856.00	30.61	24.1	54.71	74	-19.29
2480	17851.50	30.85	24.0	54.85	74	-19.15

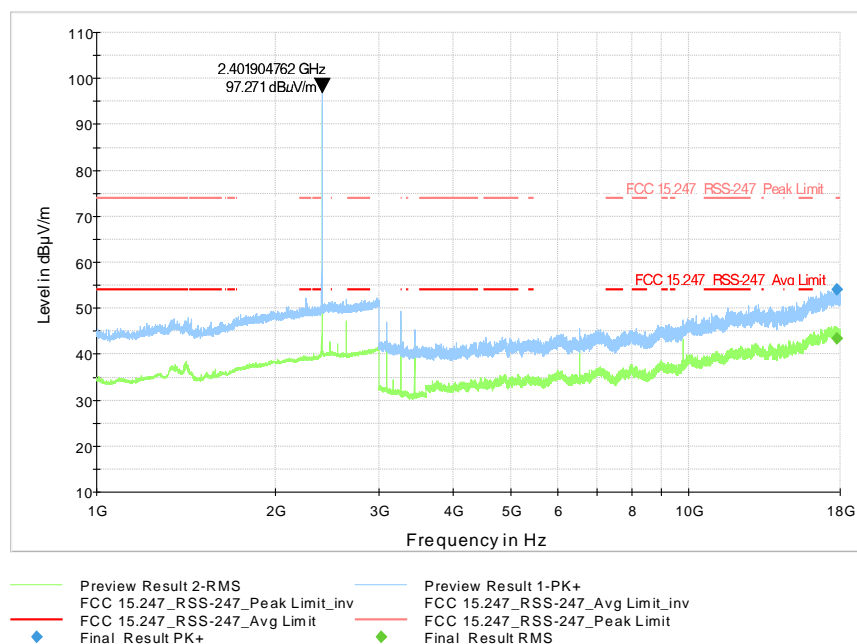
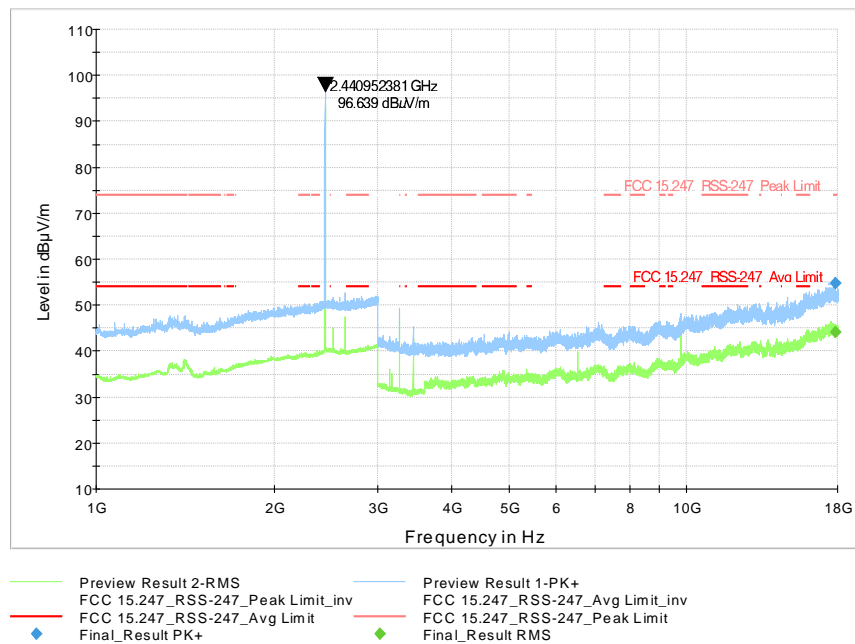
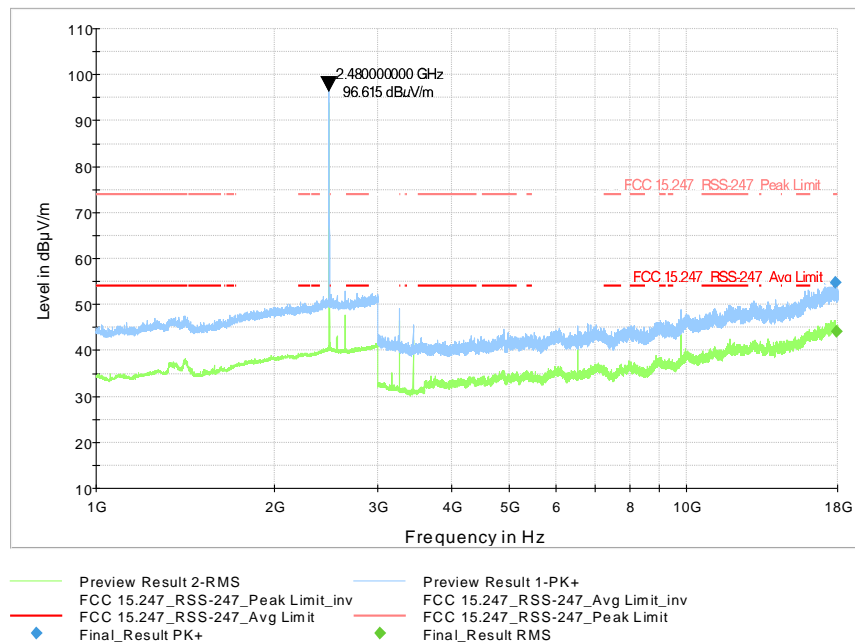


Figure 9-83 Radiated Spurious Emissions (Ch. 0) 3-DH5 (1-18 GHz)



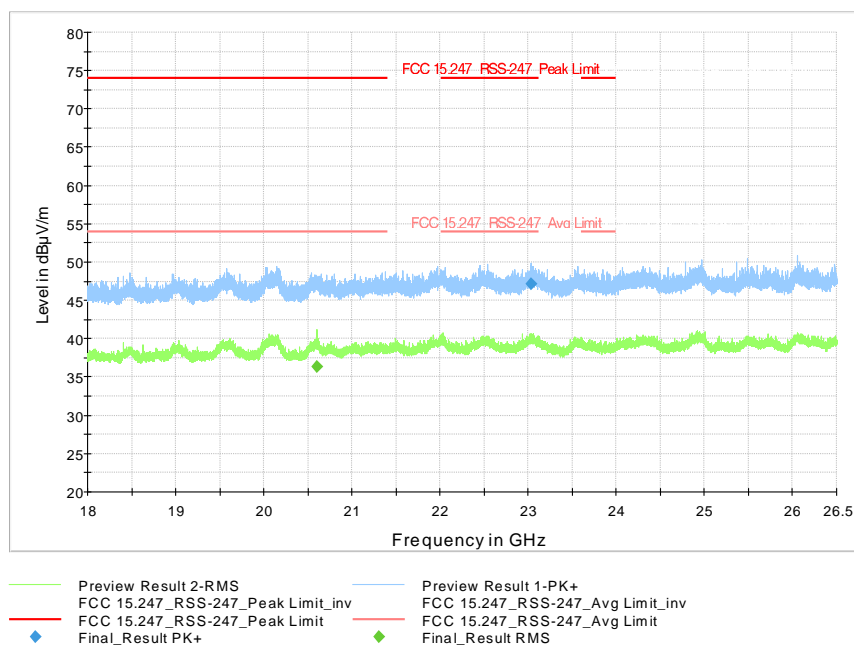
**Figure 9-84 Radiated Spurious Emissions (Ch. 39) 3-DH5 (1-18 GHz)**



**Figure 9-85 Radiated Spurious Emissions (Ch. 78) 3-DH5 (1-18 GHz)**

### 9.9.5.5 Emissions in 18-26.5 GHz range

All channels and modes of operations were tested and worst-case results from 1DH5 mode, Ch 0 shown below. No significant emissions above noise floor.



**Figure 9-86 Radiated Spurious Emissions (Ch. 0) 1-DH5 (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, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the Unsymmetric radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with the power cords that are used under normal operating conditions. These measurements are made using a LISN (Line Impedance Stabilization Network). AC powered peripherals are attached to a second LISN with the 50-ohm measuring port terminated by a 50-ohm resistive load.

The EUT was set to continuously transmit in Hopping mode on all channels.

#### EMI Receiver Settings:

**150 kHz – 30 MHz:**

RBW= 9 kHz

VBW  $\geq 3 \times$  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

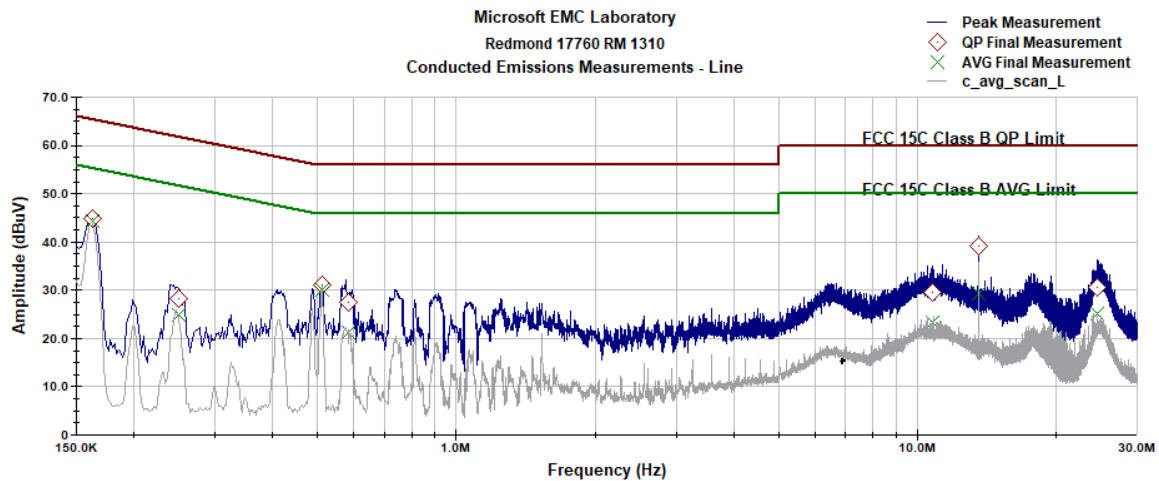
### 9.10.3 Limit

Frequency of emission (MHz)	Conducted limit (dB $\mu$ V)	
	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:

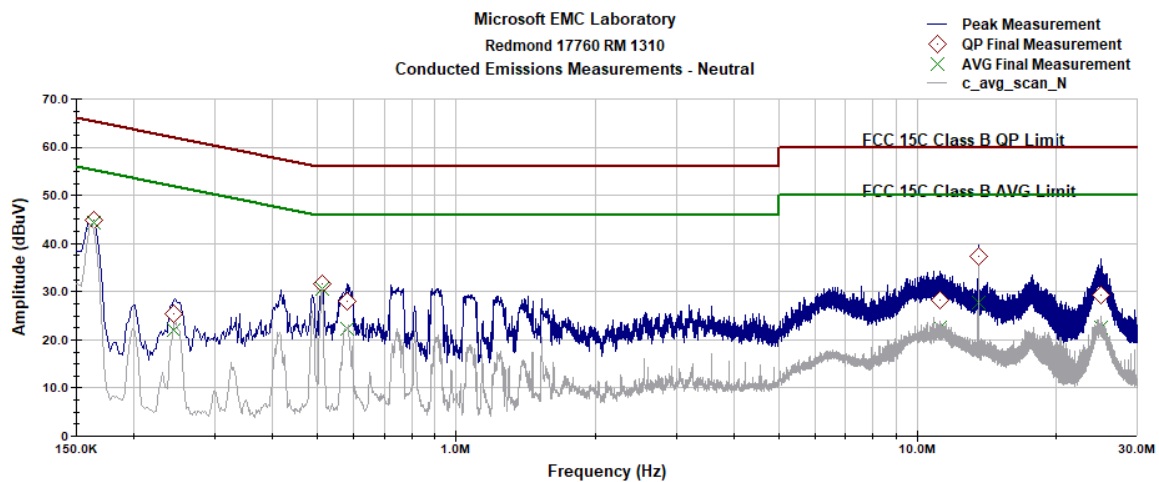


Operator: Soham Surve

Last Data Update 05:12:00 PM, Thursday, April 04, 2019

CE Profile V2.2

**Figure 9-87 AC Line Conducted Emissions- Line (150 kHz- 30 MHz)**



Operator: Soham Surve

Last Data Update 05:33:33 PM, Thursday, April 04, 2019

CE Profile V2.2

**Figure 9-88 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)
0.163	44.94	44.35	65.30	55.30	L	-20.37	-10.95
0.513	31.21	30.00	56.00	46.00	L	-24.79	-16.00
13.562	39.25	29.39	60.00	50.00	L	-20.75	-20.61
0.584	27.53	21.28	56.00	46.00	L	-28.47	-24.72
24.565	30.46	25.10	60.00	50.00	L	-29.54	-24.90
10.778	29.43	23.32	60.00	50.00	L	-30.57	-26.68
0.251	28.31	24.81	61.73	51.73	L	-33.43	-26.92
0.163	44.93	44.28	65.29	55.29	N	-20.37	-11.01
0.511	31.66	30.50	56.00	46.00	N	-24.34	-15.50
13.562	37.45	27.79	60.00	50.00	N	-22.55	-22.21
0.581	28.10	22.19	56.00	46.00	N	-27.90	-23.81
11.199	28.36	22.55	60.00	50.00	N	-31.64	-27.45
25.030	29.27	22.55	60.00	50.00	N	-30.74	-27.45
0.244	25.50	22.05	61.95	51.95	N	-36.45	-29.90

# End of Report