RADIO TEST REPORT

For

MODEL NO.: 1855
FCC ID: C3K1855
IC ID: 3048A-1855

Test Report No. R-TR516-FCCISED-BTLE-2
Issue Date: July 15th, 2019

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

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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	5/24/2019	All	All	Version 1.0	Nisha Nandakumar
2.0	07/15/2019	5.1	9	Included note on USB charging cable for radiated measurements	Daniel Salinas

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Test Report Attestation

Microsoft Corporation
Model:1855
FCC ID: C3K1855
IC ID: 3048A-1855

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 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 report number R-TR516-FCCISED-BTLE-2 issued 05/31/2019.

Written By:

Nisha Nandakumar
Radio Test Engineer

Reviewed/ Issued By:

Daniel Salinas
Radio Compliance Test Lead

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
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	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:	Chaitrali Limaye
Functional Description of the EUT:	Radio transceiver device with IEEE 802.11a/b/g/n/ac MIMO radio supporting 20/40/80MHz bandwidths, Bluetooth 5.0.
Model:	1855
FCC ID:	C3K1855
IC ID:	3048A-1855
Radio under test:	BTLE (2402- 2480 MHz)
Modulation(s):	GFSK
Antenna Information:	Integral Antenna. **Manufacturer declared max Antenna Gain in 2.4GHz band of operation:** 3.90 dBi
EUT Classification:	DTS
Equipment Design State:	Prototype/Production Equivalent (EV3)
Equipment Condition:	Good
Test Sample Details:	**RF Conducted Test Sample** Asset No: R-516-122718-01 S/N: A24964030112844A **RF Radiated Test Sample** Asset No: R-516-050219-10, S/N: 900054391556 Asset No: R-516-042219-06, S/N: 900128190956 Asset No: R-516-040919-05, S/N: 900218190956

5.1 Test Configurations

Test software “QRCT” (V3.0.271.0) and “QRCT” (V4.0.00113) provided by the customer was used to program the EUT to transmit continuously.

The device can operate in only GFSK modulation. Channel numbers 0, 19 and 38 were used as Low, Mid and High Channels, respectively.

All radiated testing reported was performed with the USB charging cord connected as these results were worst case.

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 from Feb 19th, 2019 to May 13th, 2019.

6 Test Results Summary

Test Description	FCC CFR 47/ ISED Rule Part	Limit	Test Result
Duty Cycle	Reporting & Measurements	Reporting & Measurement Purposes only	N/A
6dB Bandwidth	15.247 (a)(2) RSS-247 [5.2]	≥ 500kHz	Pass
Occupied Bandwidth	Reporting & Measurements	Reporting & Measurement Purposes only	N/A
Output Power	15.247 (b)(3) RSS-247 [5.4]	≤ 1 Watt	Pass
Equivalent Isotropic Radiated Power	RSS-247 [5.4]	≤ 4 Watt	Pass
Power Spectral Density	15.247 (e) RSS-247 [5.2]	≤ 8dBm/3kHz	Pass
Conducted Band Edge/Unwanted Emissions	15.247 (d) RSS-247 [5.5]	At least 20dBc	Pass
Radiated Spurious Emissions/ Restricted Band Emissions	15.205, 15.209 RSS-247 [5.5] RSS-Gen [8.9]	FCC CFR 47 15.209 limits RSS-Gen [8.9]	Pass
AC Power Line Conducted Emissions	15.207 RSS-Gen [8.8]	FCC CFR 47 15.207 limits RSS-Gen [8.8]	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	4/10/2020
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-248	4/11/2020
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-229	4/10/2020
Keysight	Spectrum Analyzer	N9010A	EMC-1213	11/8/2019
Agilent	Spectrum Analyzer	N9030A	EMC-607	2/10/2020
Agilent	Spectrum Analyzer	N9030A	EMC-061	4/23/2020
Sunol Sciences	Antenna - Broadband Hybrid	JB6	EMC-639	8/17/2019
ETS-Lindgren	Antenna	3117-PA	EMC-858	10/8/2019
ETS-Lindgren	Antenna	3117-PA	RF-139	6/1/2019
ETS-Lindgren	Antenna - Standard Gain	3160-09	RF-179	7/30/2019
Rohde & Schwarz	Custom Filter Bank+PreAmp	SFUNIT RX	RF-322	12/4/2019
Rohde & Schwarz	Custom Filter Bank+PreAmp	SFUNIT RX	RF-323	11/29/2019
Rohde & Schwarz	PreAmp	TS-PR26	RF-199	11/29/2019
Rohde & Schwarz	Switch and Control Unit	OSP130	RF-569	7/23/2019
Rohde & Schwarz	Switch and Control Unit	OSP130	RF-018	12/4/2019
Rohde & Schwarz	Switch and Control Unit	OSP130	RF-249	11/29/2019
Rohde & Schwarz	Switch and Control Unit	OSP150	RF-019	12/4/2019
Rohde & Schwarz	Switch and Control Unit	OSP150	RF-250	11/29/2019
Murata	RF Cable	MXJA01JA1000	RF-828	NA

Equipment used for Radiated and Conducted Measurements				
Manufacturer	**Description**	**Model #**	**Asset #**	**Calibration Due**
Digi-Key	RF Cable	MXFR01JA1000	RF-847	NA
Micro-Coax	RF Cable	UTI Flex	RF-359	NA
Micro-Coax	RF Cable	UTI Flex	RF-354	NA
Micro-Coax	RF Cable		RF-274	8/14/2019
Huber & Suhner	RF Cable	SucoFlex 100	RF-452	NA
Huber & Suhner	RF Cable	SucoFlex 100	RF-350	NA
Huber & Suhner	RF Cable	SucoFlex 102A	RF-269	NA
Huber & Suhner	RF Cable	SucoFlex 106A	RF-599	NA
PCE	Climate Meter	PCE- THB 40	EMC-1207	9/28/2019
PCE	Climate Meter	PCE- THB 40	EMC-1206	9/28/2019
Madge Tech	THP Monitor	PRHT Temp 2000	EMC-170	10/18/2019
Micro-Coax	RF Cable	UTI Flex	RF-647	NA
Micro-Coax	RF Cable	UTI Flex	RF-646	NA
Micro-Coax	RF Cable	UFA210A-Q-2755-3005GU	EMC-648	NA
Micro-Coax	RF Cable	UFA0311-1-0787-50U50U	EMC-351	NA
Micro-Coax	RF Cable	UFB311A-0-2756-5005G0	EMC-865	NA
Micro-Coax	RF Cable	UFA210A-0-0787-300300	RF-297	NA
Pasternack	Attenuator	PE7004-6	EMC-950	8/17/2019
MCL	Attenuator	BHBW-S6-2W263+	RF-710	NA
Pasternack	Attenuator	PE7087-6	RF-801	NA
Rhode & Schwarz	Software	EMC-32 V10.01.00	RF-464	NA

Equipment used for AC Line Conducted Emissions Measurement				
Manufacturer	**Description**	**Model #**	**Asset #**	**Calibration Due**
Rohde & Schwarz	Analyzer/ Receiver	ESU	RF-604	12/26/2019
Teseq	EUT LISN	NNB 051	EMC-057	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-650	7/30/2019
MadgeTech	Environmental Monitor	PRHTemp2000	EMC-1208	9/28/2019
Chroma	AC Power Source	61602	EMC-055	N/A

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

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 placed 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 flat orientation 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 1.5m. A linearly polarized antenna is positioned 3m from the EUT periphery. Guidelines in ANSI C63.10:2013 were followed with respect to maximizing the emissions. The measurement antenna is set at a fixed 1.5m height while the turntable is rotated 360 degrees and the EUT elevation angle is varied from 0 to 150 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 suspect frequencies above 1GHz.

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 take these correction factors into account.

8.3 Test Setup Diagrams

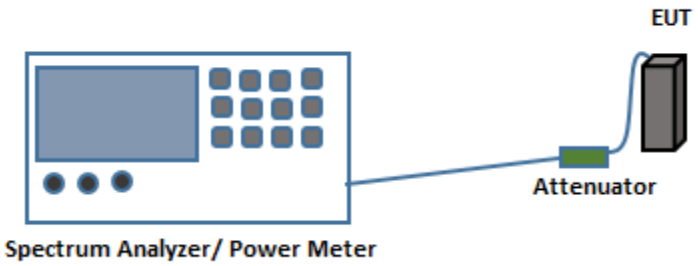

Fig.1. Test Setup for Antenna port conducted measurements

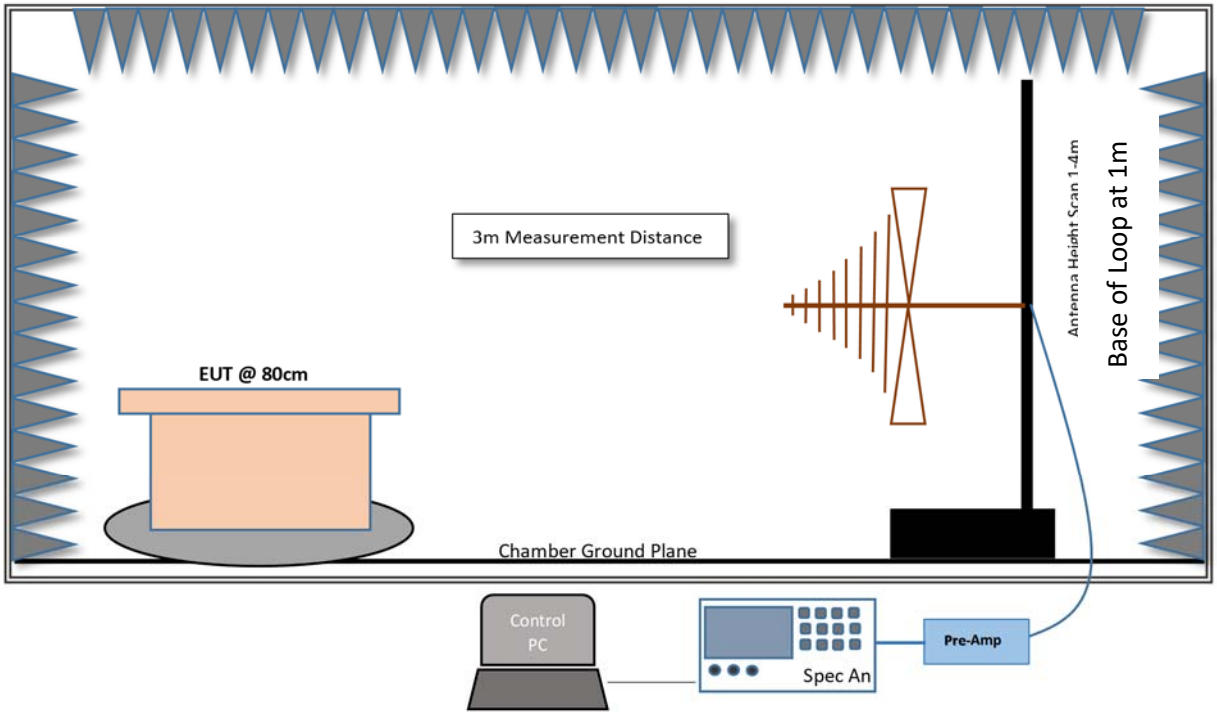

Fig.2. Test Setup for Radiated measurements in 30MHz- 1GHz Range

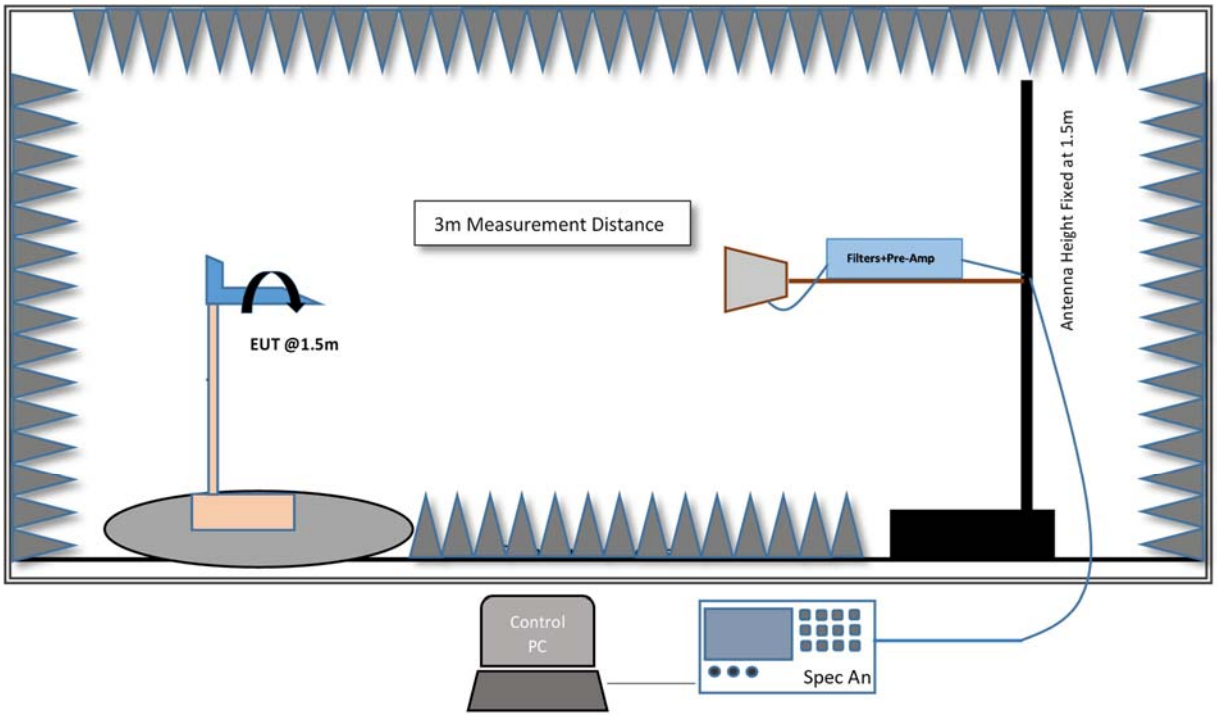

Fig.3. Test Setup for Radiated measurements in 1GHz- 18GHz Range

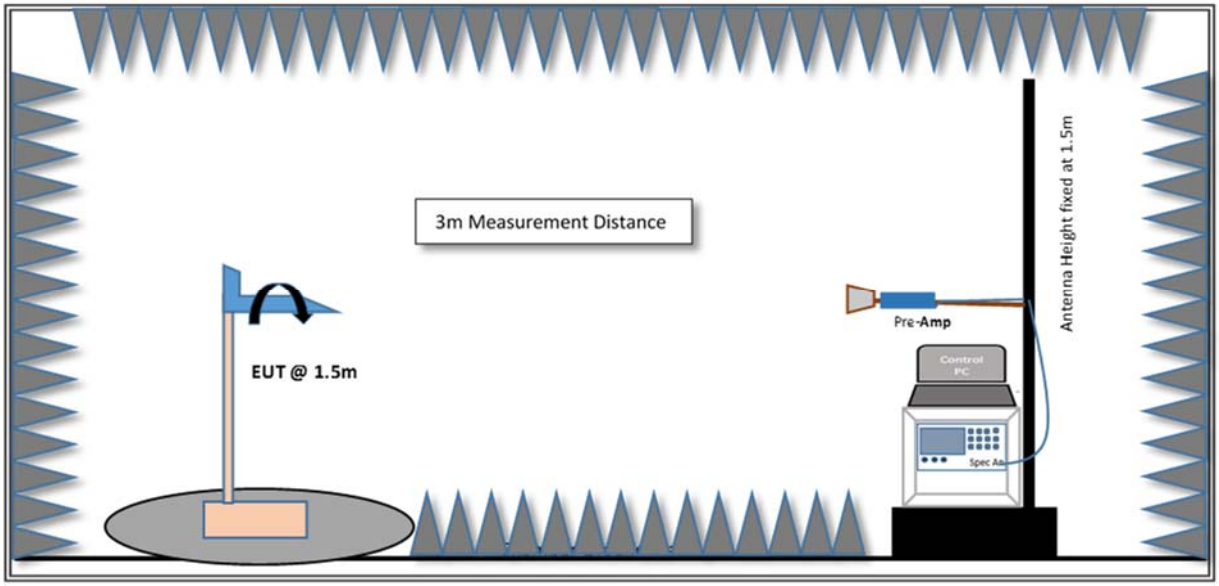

Fig.4. Test Setup for Radiated measurements >18GHz

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.

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

Sample Calculations:

Duty Cycle % = [(Ton) / (Ton +Toff)] *100
e.g. [8.60/8.67] = 0.9919*100=99.19%
If duty cycle >98% then the correction factor is 0, else the correction factor is calculated as follows.
Duty Cycle Correction Factor = 10 log*(1/DC) =10 log (1/0.92) =0.362dB

9.1.3 Limits:

Reporting and measurement purposes only.

9.1.4 Test Results:

Frequency (MHz)	Band width (MHz)	On Time (ms)	Period (ms)	Duty Cycle (%)	Correction Factor (dB)
2402	2	0.200	0.626	31.95	4.96
2402	1	0.390	0.626	62.30	2.06

9.1.5 Test Data:

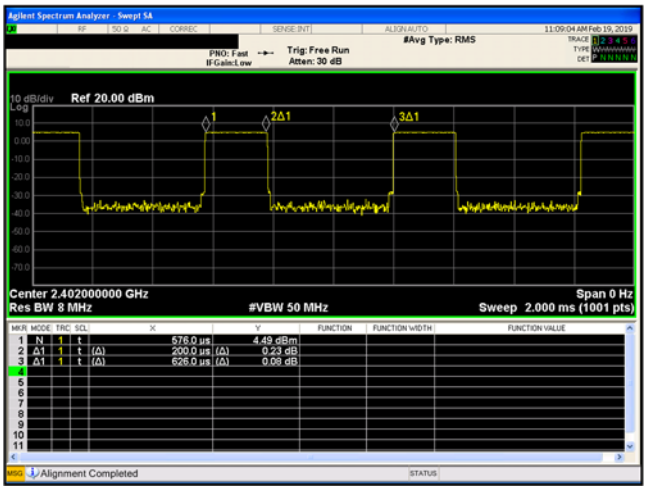

Figure 9-1 Duty Cycle 2402MHz (Ch.0) - 2MHz BW

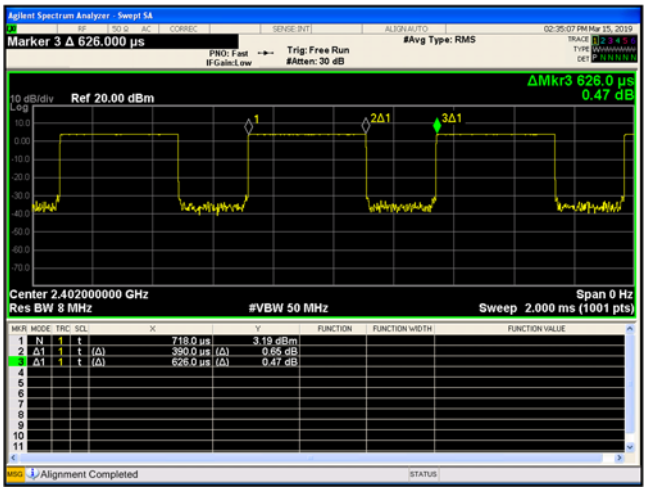

Figure 9-2 Duty Cycle 2402MHz (Ch.0) - 1MHz BW

9.2 6-dB Bandwidth

9.2.1 Test Requirement:

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

ISED RSS-247 [5.2]

9.2.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Sample Calculations:

Corrected Amplitude: Amplitude (Analyzer level) + CL (Cable losses) = -25 dBm + 5 dB = -20dBm.

Spectrum Analyzer settings:
RBW= 100 kHz
VBW ≥ 3 RBW= 300 kHz.
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto Couple
The in-built functionality of the Spectrum Analyzer is used to measure the 6-dB bandwidth.

9.2.3 Limits:

The 6-dB bandwidth shall be at least 500 kHz

9.2.4 Test Results:

Frequency (MHz)	Bandwidth (MHz)	Channel No.	6dB Bandwidth (kHz)	Limit (kHz)	Result
2402	2	0	1135	>500	Pass
2440	2	19	1121	>500	Pass
2480	2	39	1134	>500	Pass
2402	1	0	662.8	>500	Pass
2440	1	19	664.5	>500	Pass
2480	1	39	664.8	>500	Pass

9.2.5 Test Data:

Figure 9-3 6dB Bandwidth (Ch. 0) – 2MHz BW

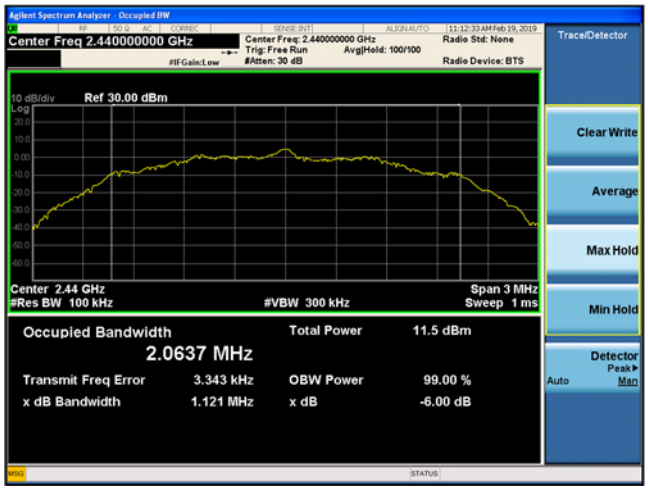

Figure 9-4 6dB Bandwidth (Ch. 19) – 2MHz BW

Figure 9-5 6dB Bandwidth (Ch. 39) – 2MHz BW

Figure 9-6 6dB Bandwidth (Ch. 0) – 1MHz BW

Figure 9-7 6dB Bandwidth (Ch. 19) – 1MHz BW

Figure 9-8 6dB Bandwidth (Ch. 39) – 1MHz BW

9.3 99% Occupied Bandwidth

9.3.1 Test Requirement:

The 99% Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal. This test is performed for reporting and measurement purposes only.

9.3.2 Test Method:

Measurements are performed according to ANSI C63.10: 2013.

Spectrum Analyzer settings:
Set analyzer center frequency to the nominal EUT channel frequency
Span is set to between 1.5 and 5.0 times the DTS bandwidth
RBW to: 1% to 5% of the OBW= 30 kHz
VBW ≥ 3 RBW= 100 kHz
Detector = Peak
Sweep time = Auto Couple
Trace mode = max hold
Use the 99% power bandwidth function of the instrument.

Sample Calculations:

Corrected Amplitude: Amplitude (Analyzer level) + CL (Cable losses) = -25 dBm + 5 dB = -20dBm.

9.3.3 Limits:

For reporting purpose only.

9.3.4 Test Results:

Frequency (MHz)	Bandwidth (MHz)	Channel No.	99% Bandwidth (MHz)
2402	2	0	2.038
2440	2	19	2.038
2480	2	39	2.035
2402	1	0	1.034
2440	1	19	1.033
2480	1	39	1.034

9.3.5 Test Data:

Figure 9-9 99% Bandwidth (Ch. 0) - 2MHz BW

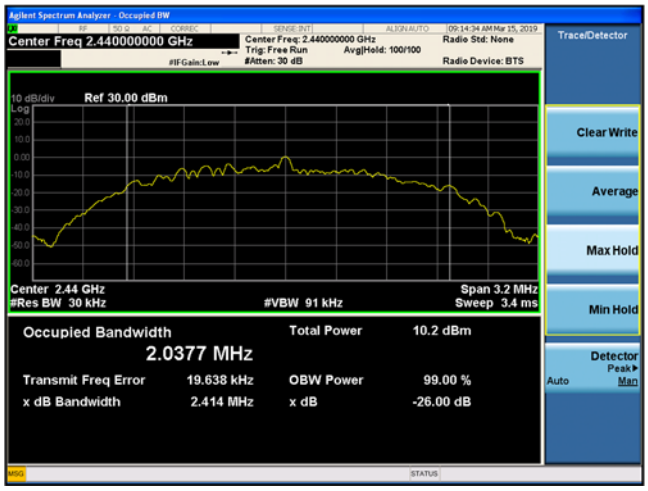

Figure 9-10 99% Bandwidth (Ch. 19) - 2MHz BW

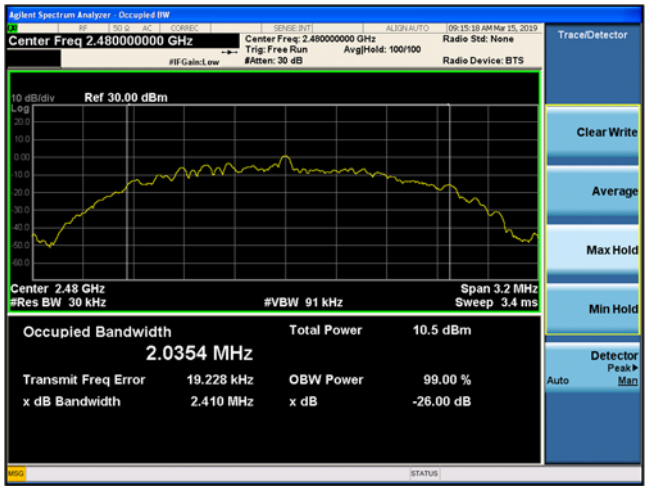

Figure 9-11 99% Bandwidth (Ch. 39) - 2MHz BW

Figure 9-12 99% Bandwidth (Ch. 0) - 1MHz BW

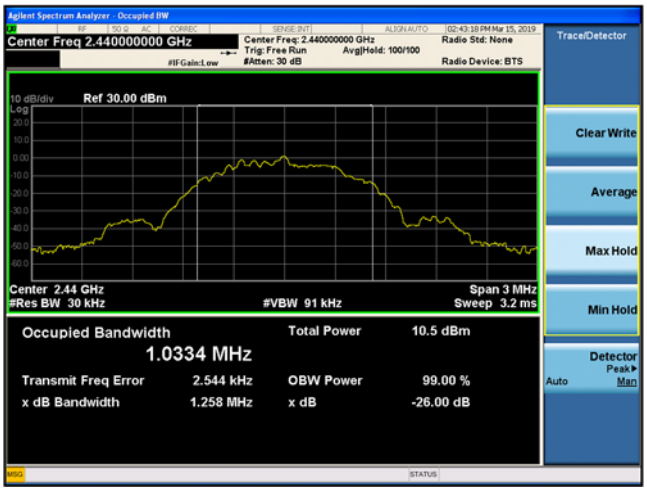

Figure 9-13 99% Bandwidth (Ch. 19) - 1MHz BW

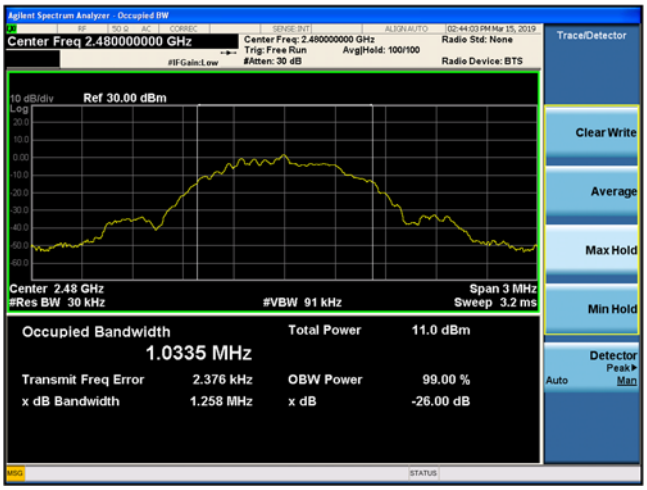

Figure 9-14 99% Bandwidth (Ch. 39) - 1MHz BW

9.4 Output Power

9.4.1 Test Requirement:

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

ISED RSS-247 [5.4]

9.4.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:
Peak Power:
RBW= 1 MHz
VBW= 3 MHz
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto Couple
Span= 3 MHz

Sample Calculations:

Effective Isotropic Radiated Power (EIRP) : Amplitude (Analyzer level) + CL (Cable losses) + Antenna Gain = -25 dBm + 5 dB +3 dB = -17dBm.

9.4.3 Limits:

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

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

9.4.4 Test Results:

Frequency (MHz)	Bandwidth (MHz)	Channel No.	Cond. Peak Power (dBm)	Cond. Peak Limit (dBm)	Margin (dB)	Result
2402	2	0	4.86	30	-25.14	Pass
2440	2	19	5.21	30	-24.79	Pass
2480	2	39	5.57	30	-24.43	Pass
2402	1	0	3.53	30	-26.47	Pass
2440	1	19	3.96	30	-26.04	Pass
2480	1	39	4.36	30	-25.64	Pass

Frequency (MHz)	Bandwidth (MHz)	Channel No.	Cond. Peak Power (dBm)	Max Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
2402	2	0	4.86	3.9	8.76	36	-27.24	Pass
2440	2	19	5.21	3.9	9.11	36	-26.89	Pass
2480	2	39	5.57	3.9	9.47	36	-26.53	Pass
2402	1	0	3.53	3.9	7.43	36	-28.57	Pass
2440	1	19	3.96	3.9	7.86	36	-28.14	Pass
2480	1	39	4.36	3.9	8.26	36	-27.74	Pass

9.4.5 Test Data:

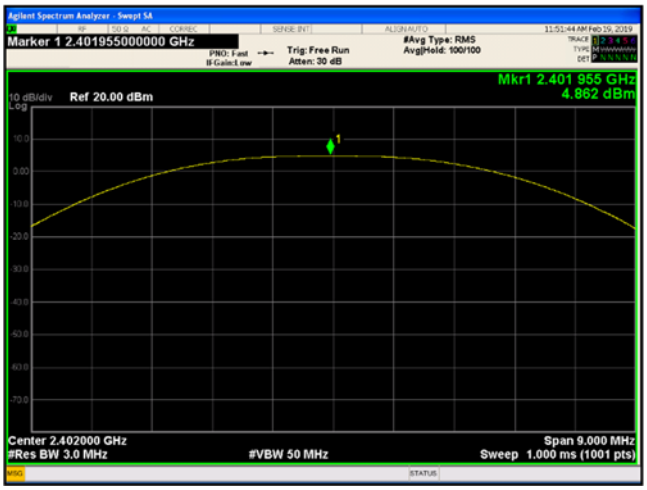

Figure 9-15 Peak Power (Ch. 0) 2MHz BW

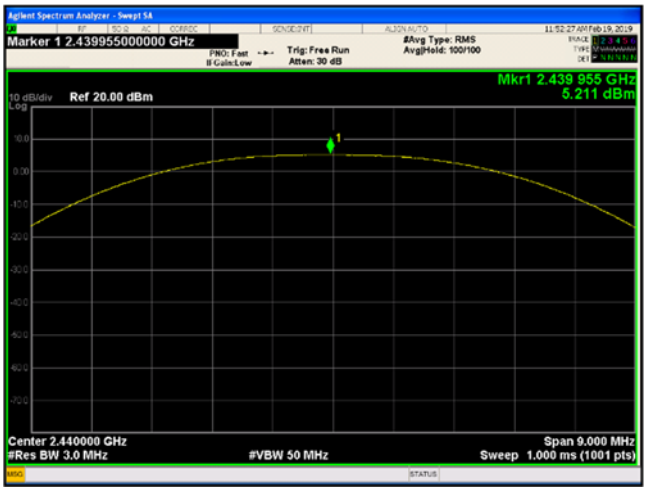

Figure 9-16 Peak Power (Ch. 19) 2MHz BW

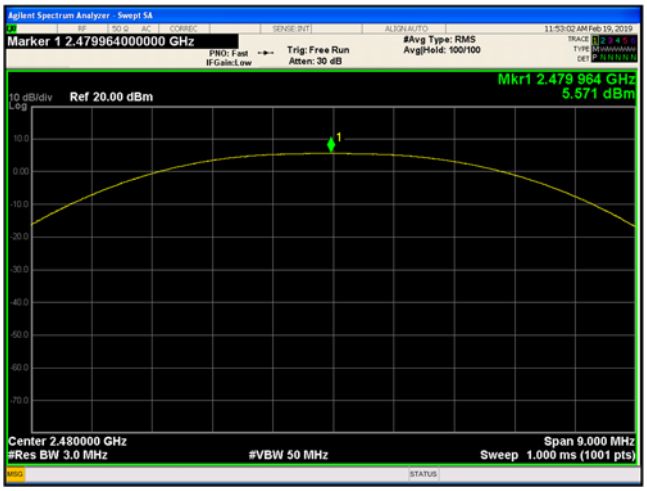

Figure 9-17 Peak Power (Ch. 39) 2MHz BW

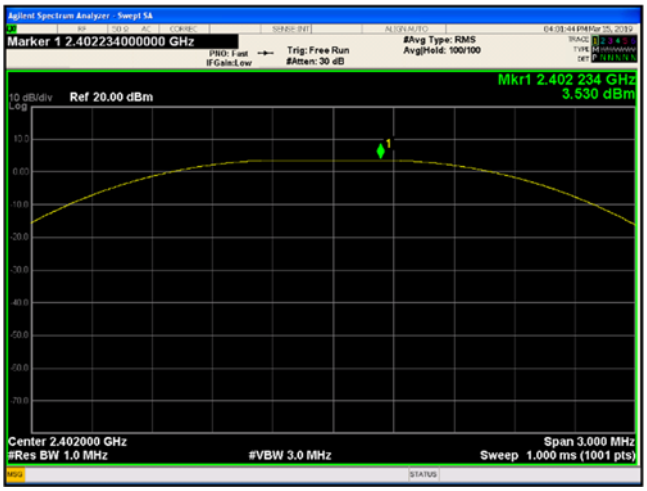

Figure 9-18 Peak Power (Ch. 0) 1MHz BW

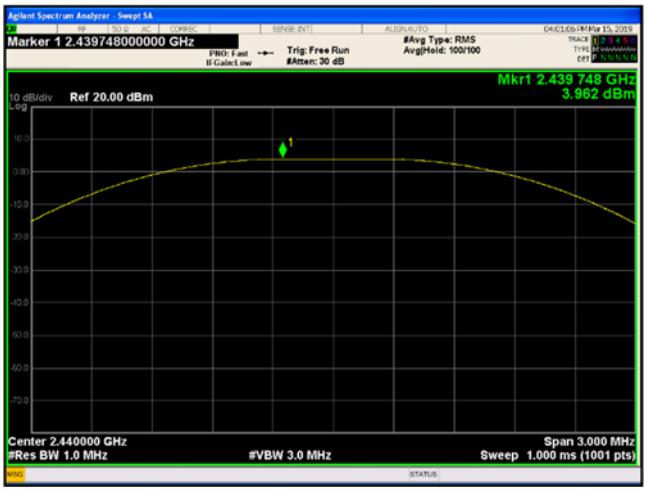

Figure 9-19 Peak Power (Ch. 19) 1MHz BW

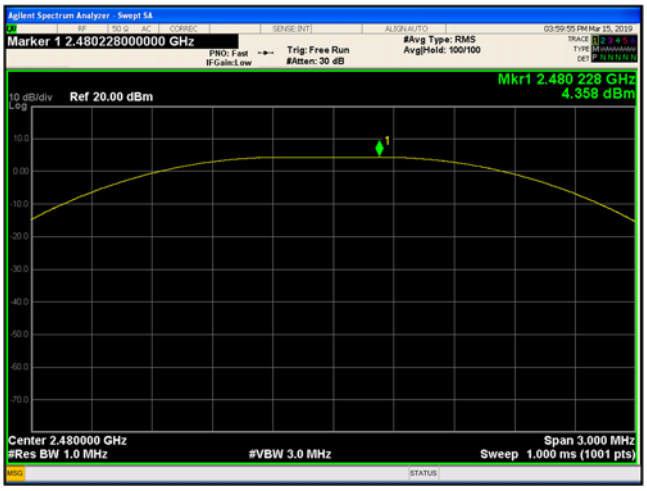

Figure 9-20 Peak Power (Ch. 39) 1MHz BW

9.5 Peak Power Density

9.5.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (e)

ISED RSS-247 [5.2]

9.5.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:
RBW= 100 kHz
VBW= 300 kHz
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto Couple
Use the peak marker function to determine the maximum amplitude level within the RBW
If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Sample Calculations:
Corrected Amplitude: Amplitude (Analyzer level) + CL (Cable losses) = -25 dBm + 5 dB = -20dBm.

9.5.3 Limits:

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

9.5.4 Test Results:

Frequency (MHz)	Bandwidth (MHz)	Channel No.	Power Spectral Density (dBm/100kHz)	Limit (dBm/3kHz)	Result
2402	2	0	4.38	8	Pass
2440	2	19	4.72	8	Pass
2480	2	39	5.08	8	Pass
2402	1	0	3.31	8	Pass
2440	1	19	3.71	8	Pass
2480	1	39	4.10	8	Pass

The test data shows that the EUT passes the requirement using 100kHz RBW setting and hence will meet the requirement for 3kHz BW.

9.5.5 Test Data:

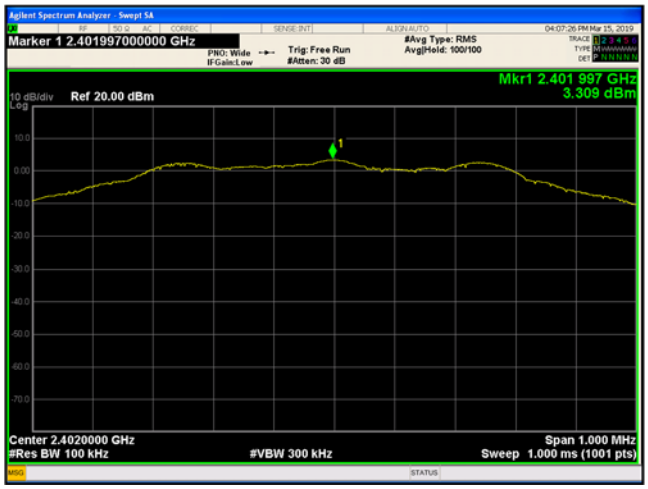

Figure 9-2 Power Spectral Density (Ch. 0) 1MHz BW

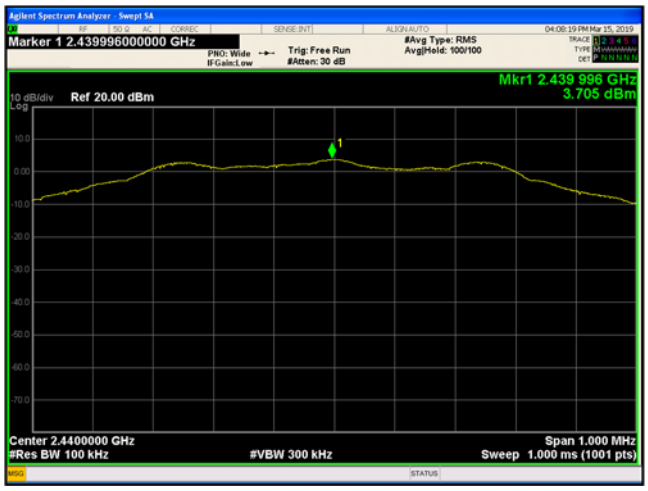

Figure 9-3 Power Spectral Density (Ch. 19) 1MHz BW

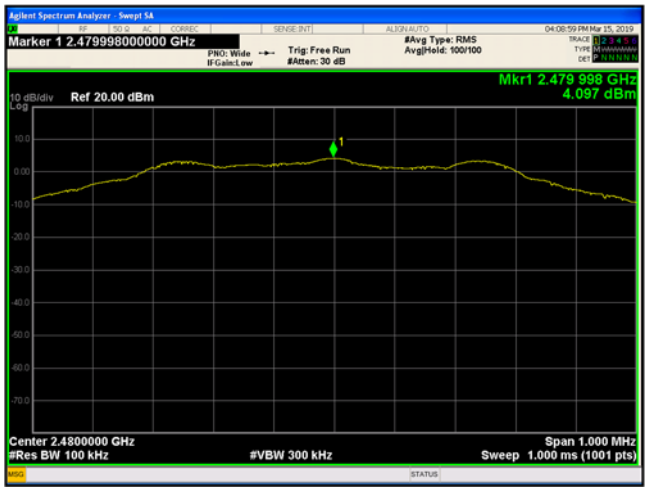

Figure 9-4 Power Spectral Density (Ch. 39) 1MHz BW

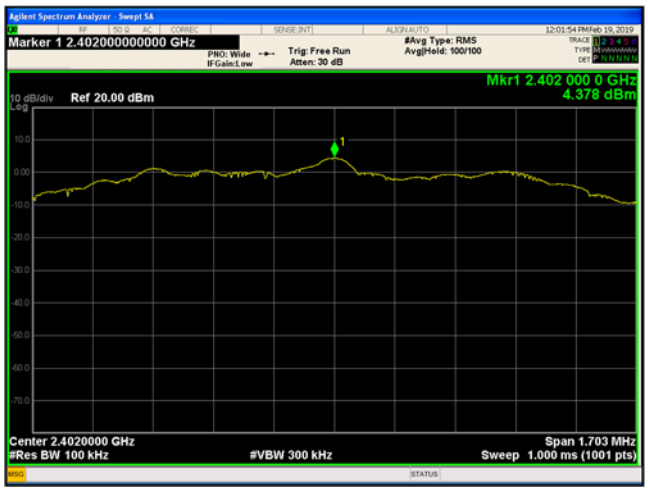

Figure 9-24 Power Spectral Density (Ch. 0) 2MHz BW

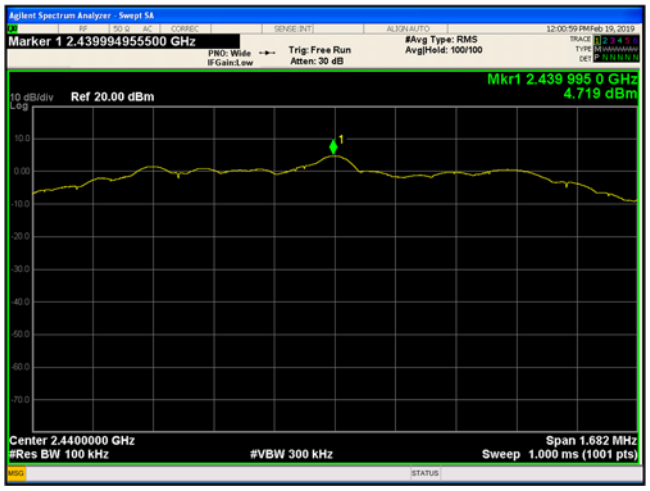

Figure 9-25 Power Spectral Density (Ch. 19) 2MHz BW

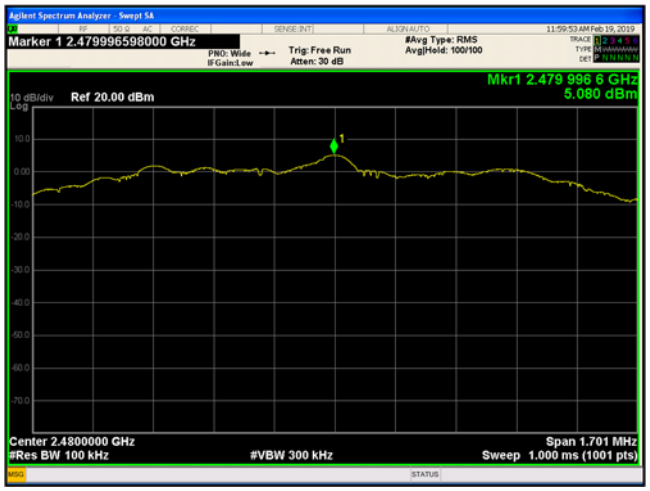

Figure 9-26 Power Spectral Density (Ch. 39) 2MHz BW

9.6 Conducted Spurious Emissions

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.6.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:
Identification of Reference Level:
RBW= 100 kHz
VBW ≥ 3 x RBW
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto Couple
Span >1.5 times DTS Bandwidth
Peak Marker function to determine the max PSD level.
Conducted Spurious Emissions:
RBW= 1 MHz
VBW≥ 3 x RBW = 3 MHz
Trace Mode = Peak Detector (Max Hold)
Sweep time = Auto Couple
Span= 30 MHz- 12 GHz; 12 GHz – 25 GHz
Sweep Points = 30000

Sample Calculations:
Corrected Amplitude: Amplitude (Analyzer level) + CL (Cable losses) = -25 dBm + 5 dB = -20dBm

9.6.3 Limits:

All spurious emissions at least 20dBc.

9.6.4 Test Result:

Channel	Carrier Frequency (MHz)	Bandwidth (MHz)	Emission Frequency (MHz)	Emissions Amplitude (dBm/MHz)	Limit (dBm)	Margin (dB)	Result
0	2402	2	3161.90	-33.56	-15.62	-17.94	Pass
0	2402	2	23815.20	-21.24	-15.62	-5.62	Pass
19	2440	2	6178.80	-33.77	-15.28	-18.49	Pass
19	2440	2	23347.20	-22.21	-15.28	-6.93	Pass
39	2480	2	6116.10	-33.06	-14.92	-18.14	Pass
39	2480	2	23838.60	-21.52	-14.92	-6.60	Pass
0	2402	1	6119.30	-31.85	-16.69	-15.16	Pass
0	2402	1	23639.30	-21.16	-16.69	-4.47	Pass
19	2440	1	5572.30	-33.58	-16.29	-17.28	Pass
19	2440	1	23827.80	-21.25	-16.29	-4.95	Pass
39	2480	1	7259.30	-33.36	-15.90	-17.45	Pass
39	2480	1	23796.20	-21.31	-15.90	-5.41	Pass

9.6.5 Test Data:

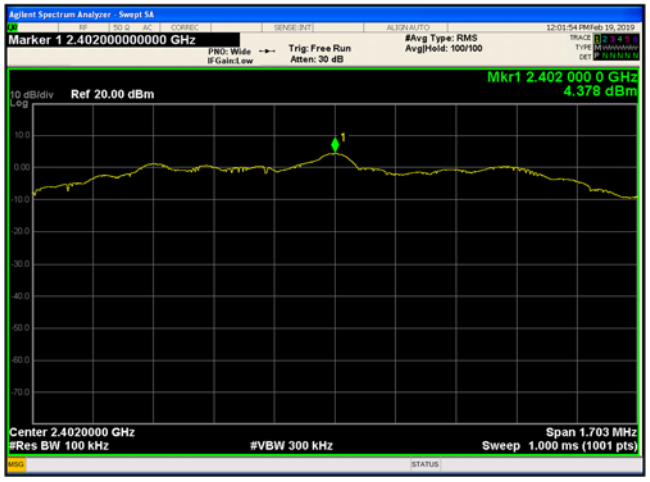

Figure 9-275 Reference Level Measurement (Ch.0) 2MHz BW

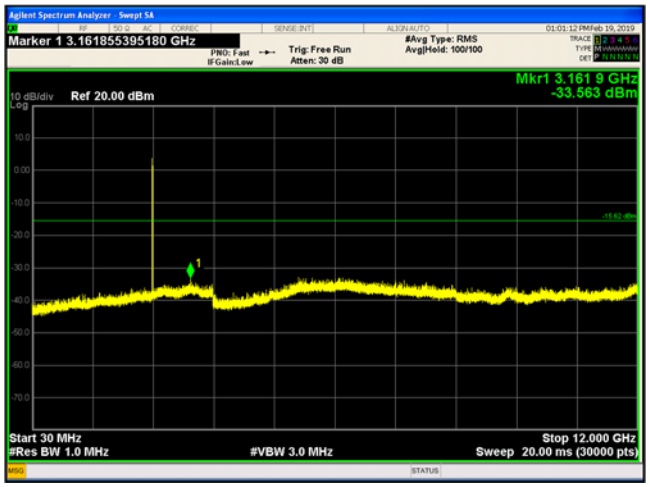

Figure 9-286 Conducted Spurious Emissions 30-12000 MHz (Ch. 0) 2MHz BW

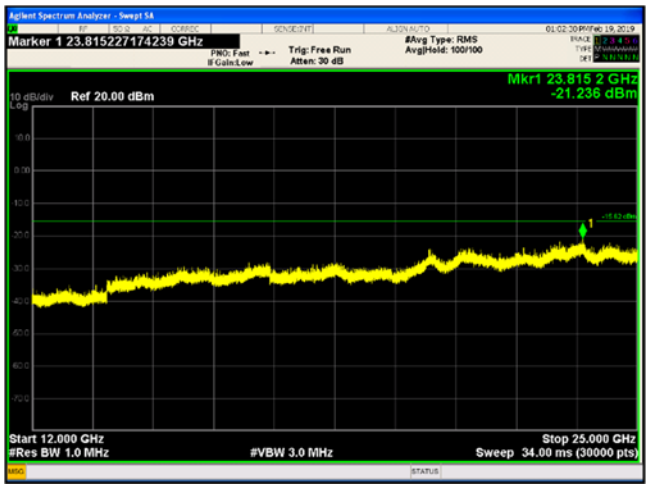

Figure 9-297 Conducted Spurious Emissions 12-25 GHz (Ch.0) 2MHz BW

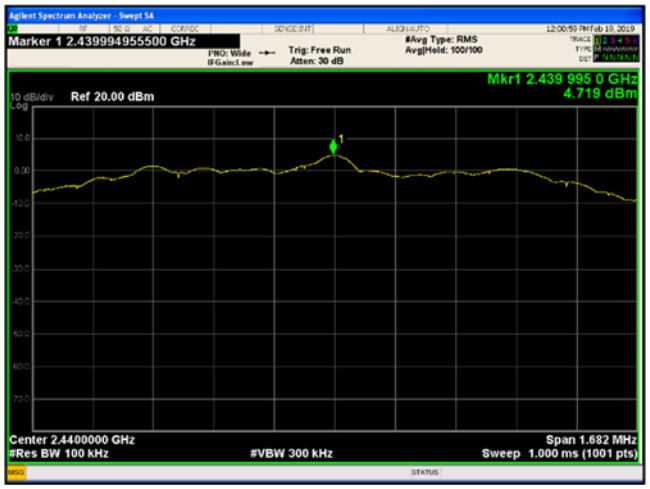

Figure 9-308 Reference Level Measurement (Ch.19) 2MHz BW

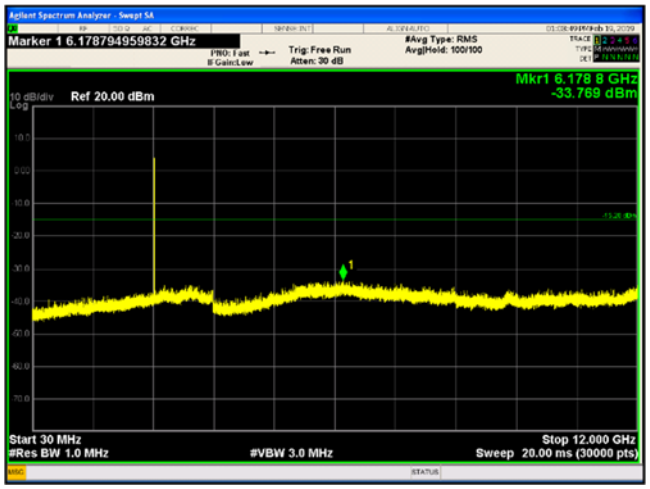

Figure 9-319 Conducted Spurious Emissions 30-12000 MHz (Ch. 19) 2MHz BW

Figure 9-3210 Conducted Spurious Emissions 12-25 GHz (Ch. 19) 2MHz BW

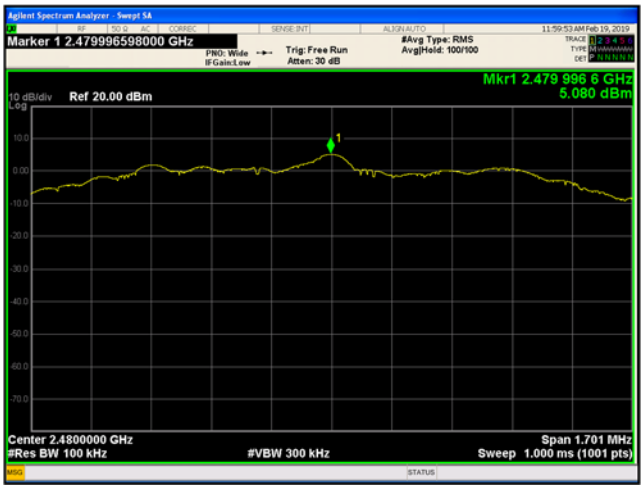

Figure 9-3311 Reference Level Measurement (Ch.39) 2MHz BW

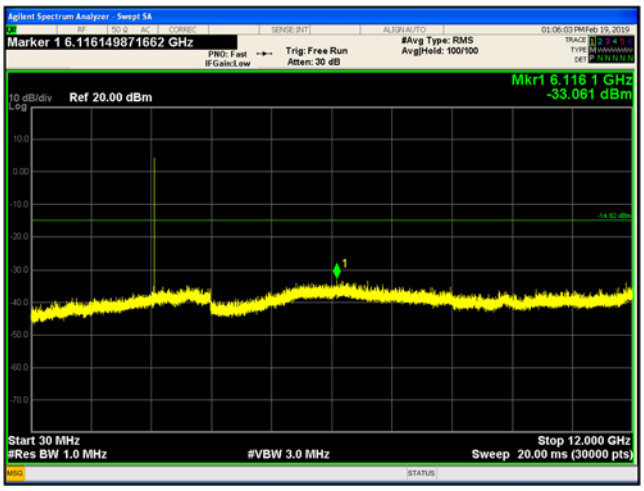

Figure 9-3412 Conducted Spurious Emissions 30-12000 MHz (Ch.39) 2MHz BW

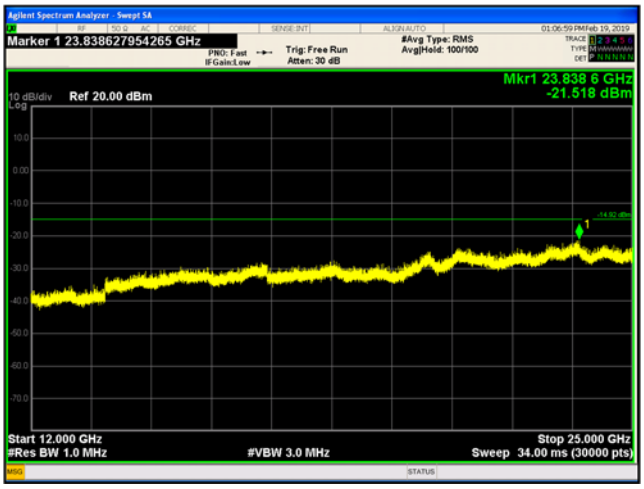

Figure 9-3513 Conducted Spurious Emissions 12-25GHz (Ch.39) 2MHz BW

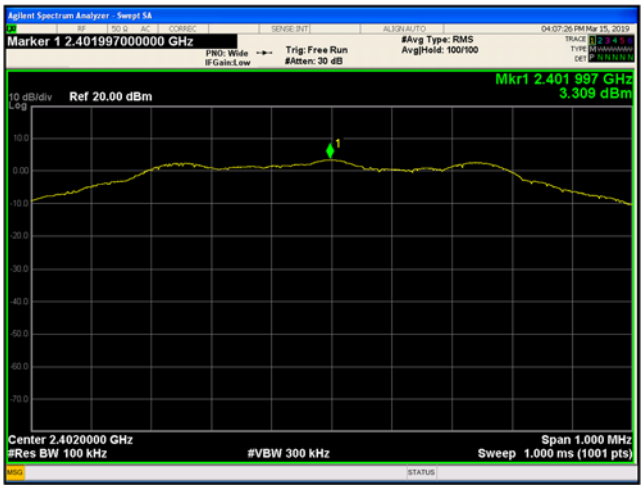

Figure 9-3614 Reference Level Measurement (Ch.0) 1MHz BW

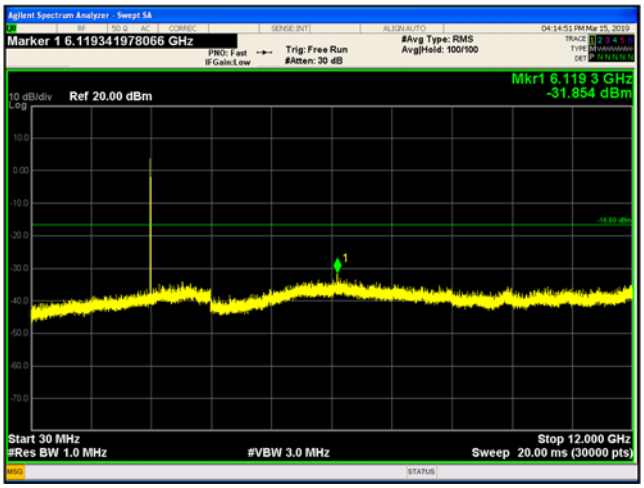

Figure 9-3715 Conducted Spurious Emissions 30-12000 MHz (Ch. 0) 1MHz BW

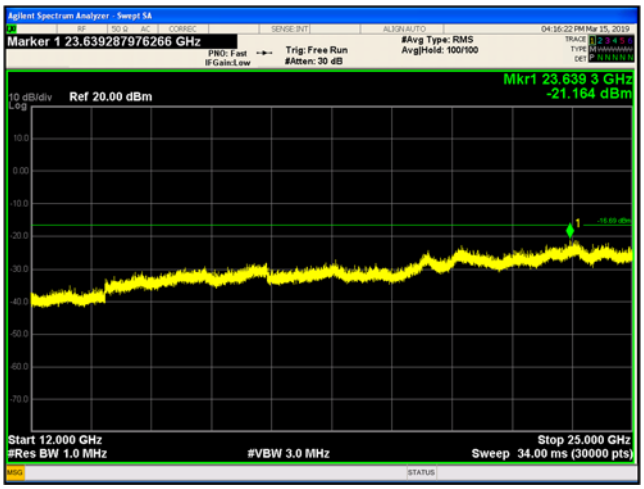

Figure 9-3816 Conducted Spurious Emissions 12-25 GHz (Ch.0) 1MHz BW

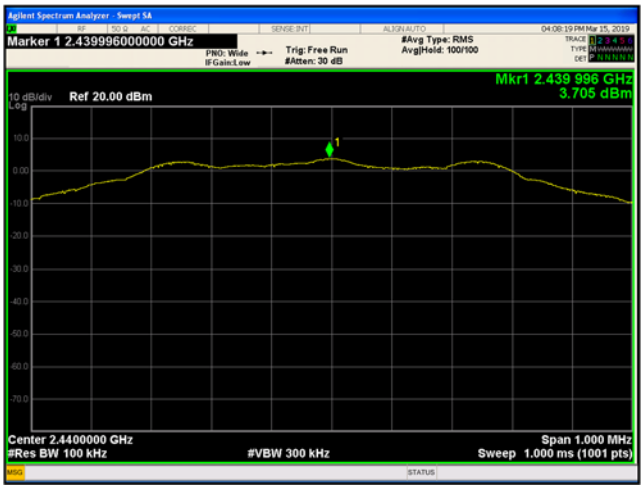

Figure 9-3917 Reference Level Measurement (Ch.19) 1MHz BW

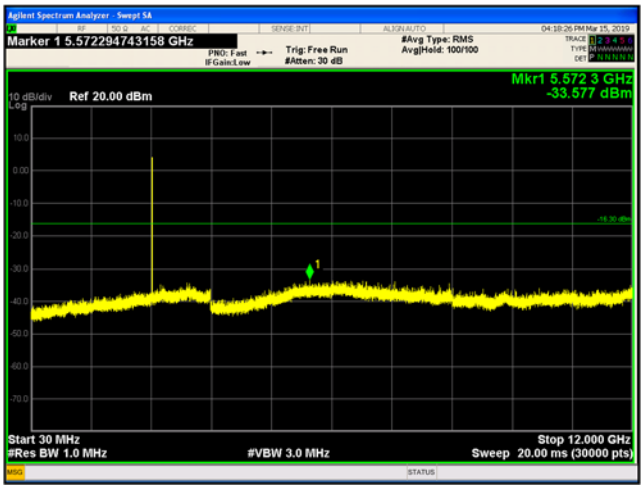

Figure 9-4018 Conducted Spurious Emissions 30-12000 MHz (Ch. 19) 1MHz BW

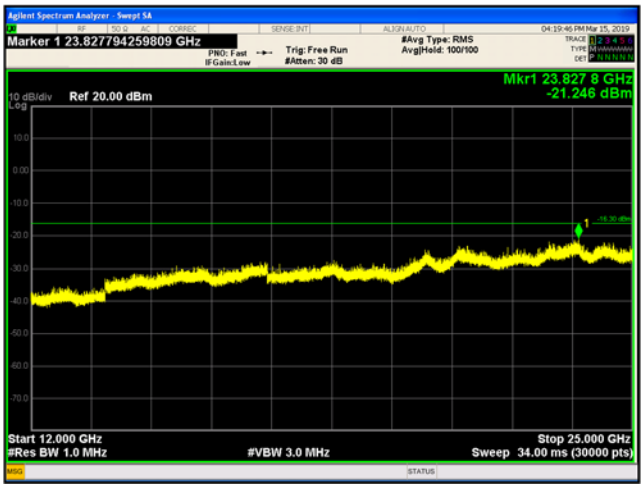

Figure 9-4119 Conducted Spurious Emissions 12-25 GHz (Ch. 19) 1MHz BW

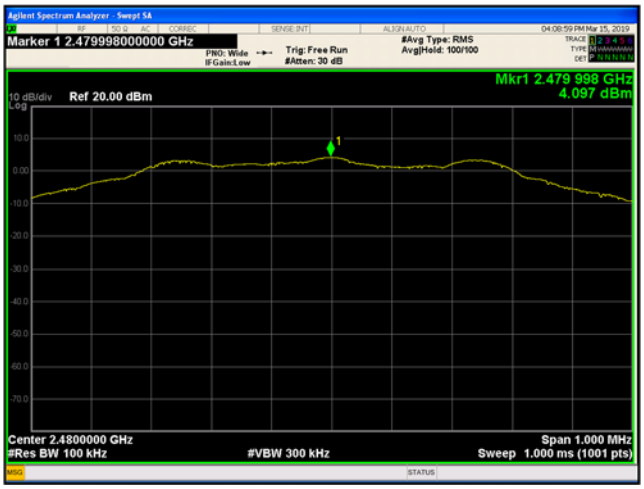

Figure 9-4220 Reference Level Measurement (Ch.39) 1MHz BW

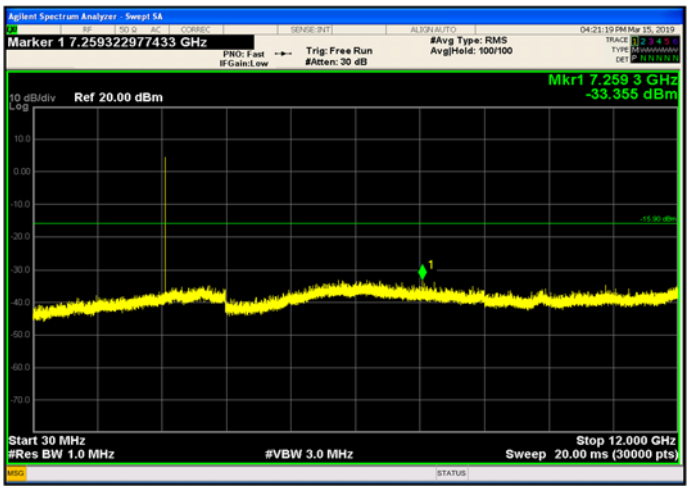

Figure 9-4321 Conducted Spurious Emissions 30-12000 MHz (Ch.39) 1MHz BW

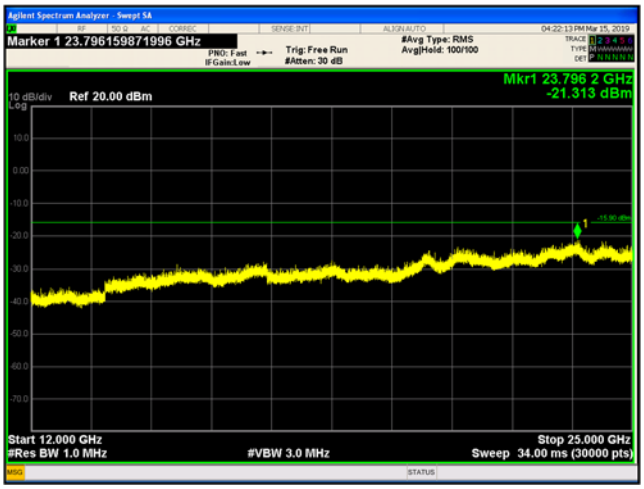

Figure 9-4422 Conducted Spurious Emissions 12-25GHz (Ch.39) 1MHz BW

9.7 Conducted Band Edge Emissions

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 KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 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 Couple
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.

Sample Calculations:
Corrected Amplitude: Amplitude (Analyzer level) + CL (Cable losses) = -25 dBm + 5 dB = -20dBm

9.7.3 Limits:

All spurious emissions at least 20dBc.

9.7.4 Test Result:

Pass.

9.7.5 Test Data:

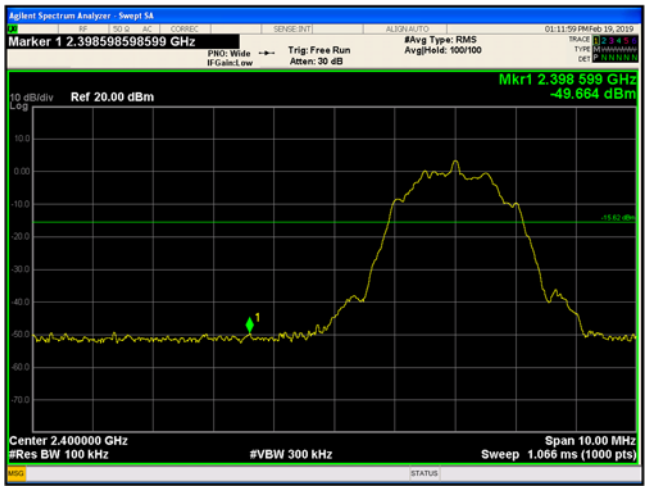

Figure 9-4523 Conducted-Low Band Edge (Ch. 0) 2MHz BW

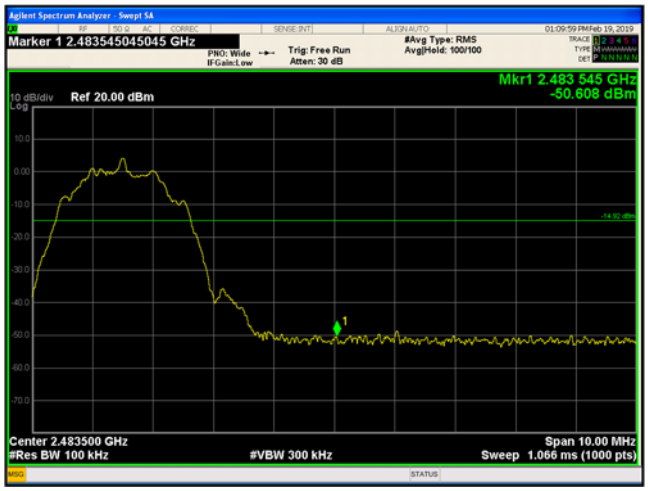

Figure 9-4624 Conducted- High Band Edge (Ch. 39) 2MHz BW

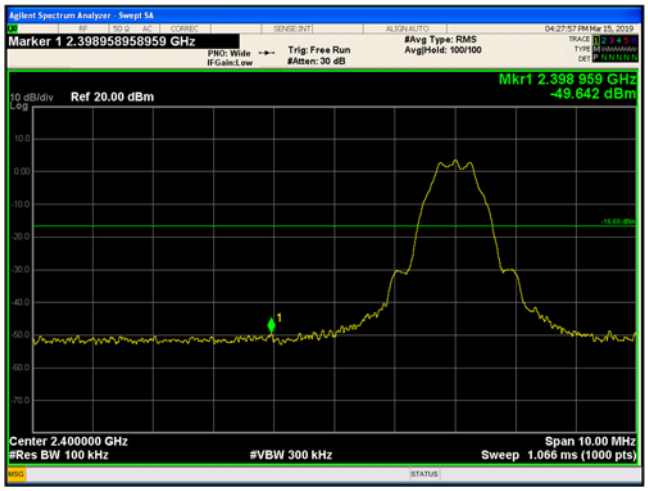

Figure 9-4725 Conducted-Low Band Edge (Ch. 0) 1MHz BW

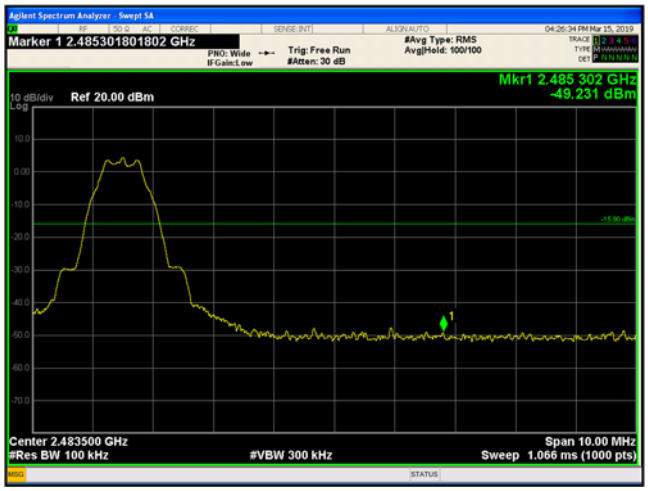

Figure 9-4826 Conducted- High Band Edge (Ch. 39) 1MHz BW

9.8 Radiated Spurious and Band Edge Emissions

9.8.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

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

9.8.2 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 30MHz to the 10th harmonic of the fundamental frequency of the transmitter. Measurements below 30MHz were not performed since the radio circuitry of the EUT does not contain clocks below 30MHz. 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. 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, 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 for both polarizations is shown in this test report.

<u>Radiated Spurious Emissions</u>
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
Sweep points ≥ 2 x 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 ≥ 2 x 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 ≥ 2 × Span/RBW
Sweep Time = Auto
RMS Average Measurements
Spectrum Analyzer Settings:
RBW = 1 MHz
VBW ≥ 3 × RBW
Detector = RMS
Span = wide enough to encompass the emission
Sweep points ≥ 2 × 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.

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 (Reduced Video Bandwidth Method)
Spectrum Analyzer Settings:
RBW= 1 MHz
VBW= 3 MHz
VBW Mode = Linear
Trace Mode: RMS detector(Average)
Span= 2310 – 2500 MHz
Sweep Points = 401
Sweep Time = Auto
Sweep Count = 200

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

Duty Cycle:

Duty Cycle (%) = $[(T_{on}) / (T_{on} + T_{off})] * 100$

If duty cycle >98% then the correction factor is 0, else the correction factor is calculated as follows.

Duty Cycle Correction Factor = 10 log*(1/DC) =10 log (1/0.92) =0.36dB

Average Measurements:

Average Amplitude + AFCL (Antenna Factor and Cable Losses) – Amplifier Gain + Duty Cycle Correction Factor = 50 dBµV + 33 dB – 25 dB + 0.36 dB = 58.36 dBµV/m

9.8.3 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 (Restricted Frequency Bands)	500	3	54 (Average) 74 (Peak)

9.8.4 Test Result:

Pass

9.8.5 Test Data:

9.8.5.1 Radiated Restricted Band-edge emissions

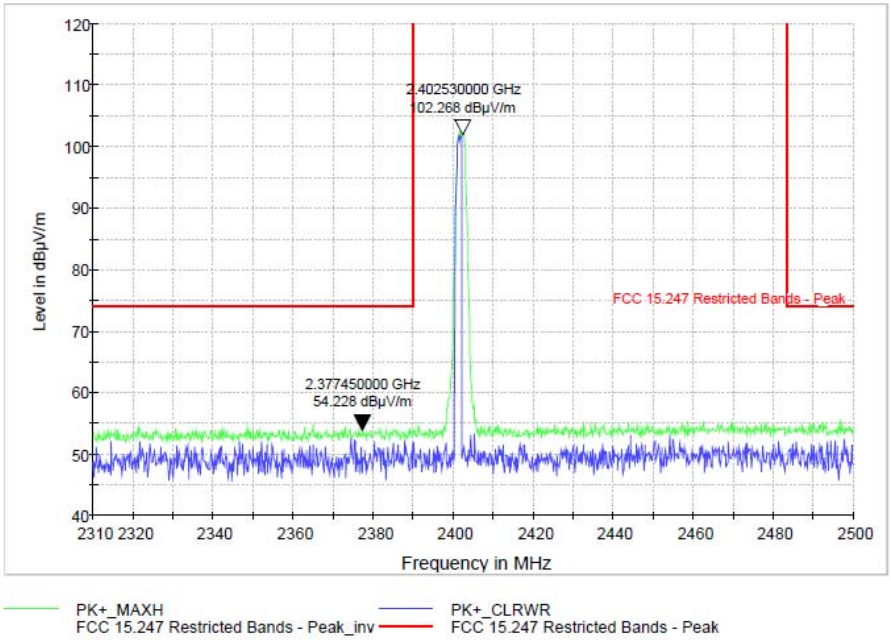

Figure 9-4927 Radiated Restricted Band Edge (Ch. 0) Peak 2MHz BW

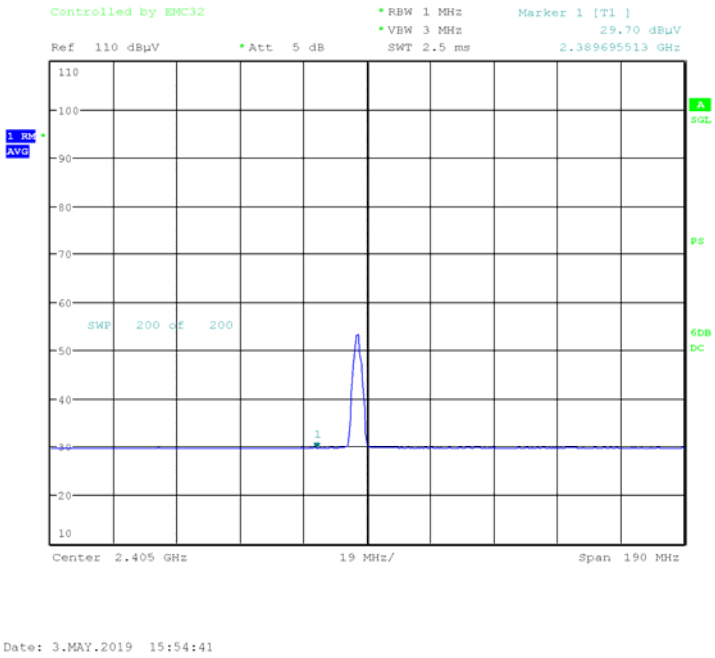

Figure 9-5028 Radiated Restricted Band Edge (Ch. 0) Average 2MHz BW

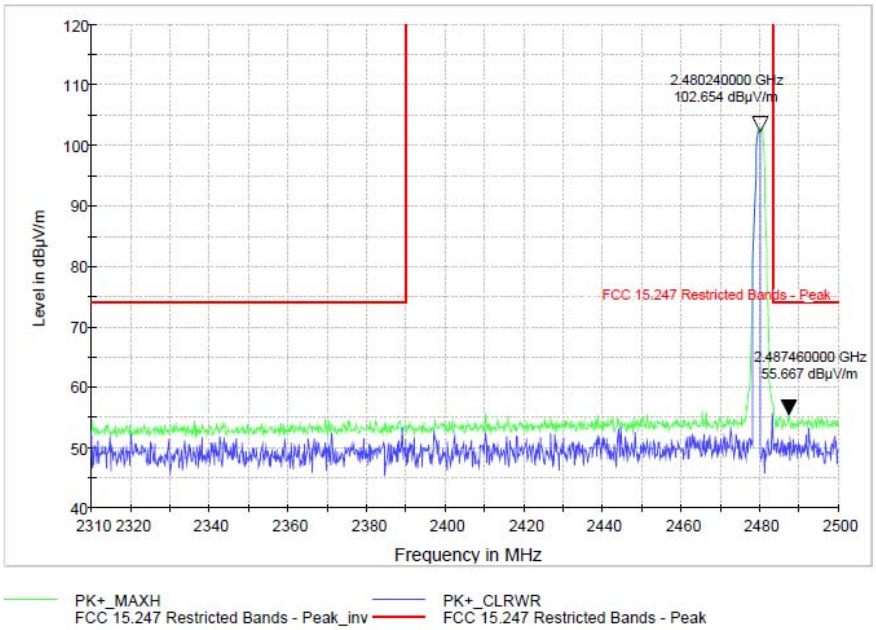

Figure 9-5129 Radiated Restricted Band Edge (Ch. 39) Peak 2MHz BW

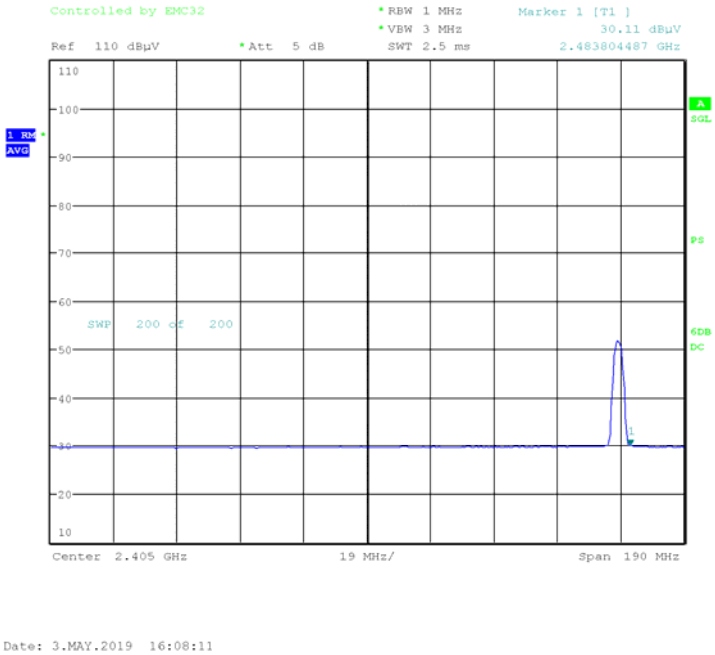

Figure 9-5230 Radiated Restricted Band Edge (Ch. 39) Average 2MHz BW

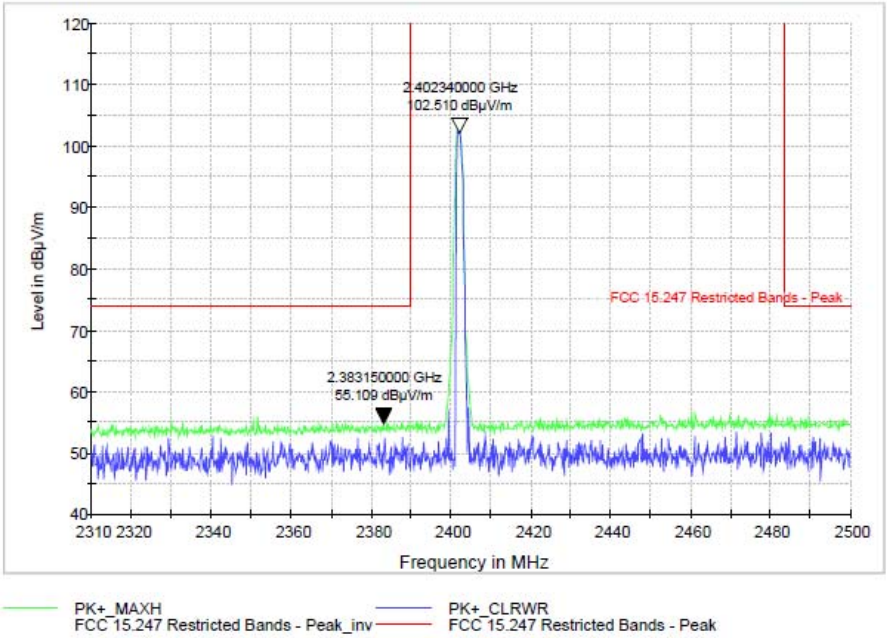

Figure 9-5331 Radiated Restricted Band Edge (Ch. 0) Peak 1MHz BW

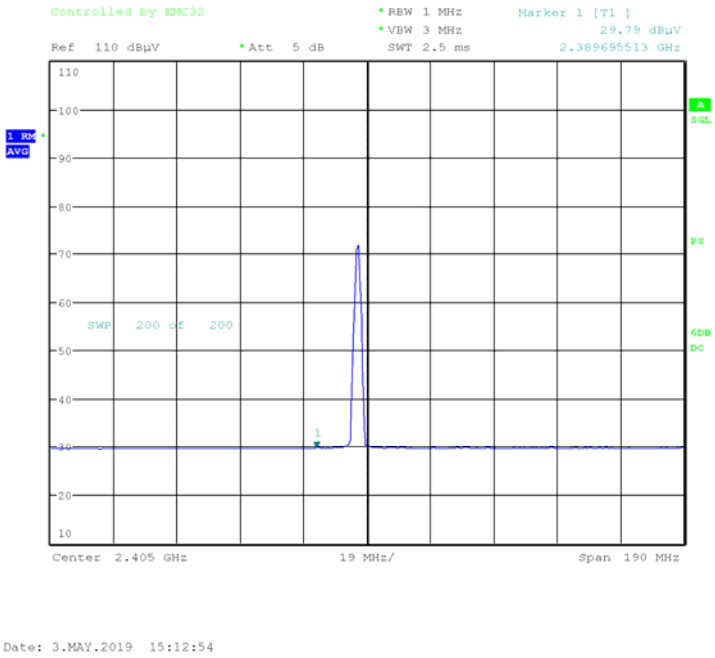

Figure 9-5432 Radiated Restricted Band Edge (Ch. 0) Average 1MHz BW

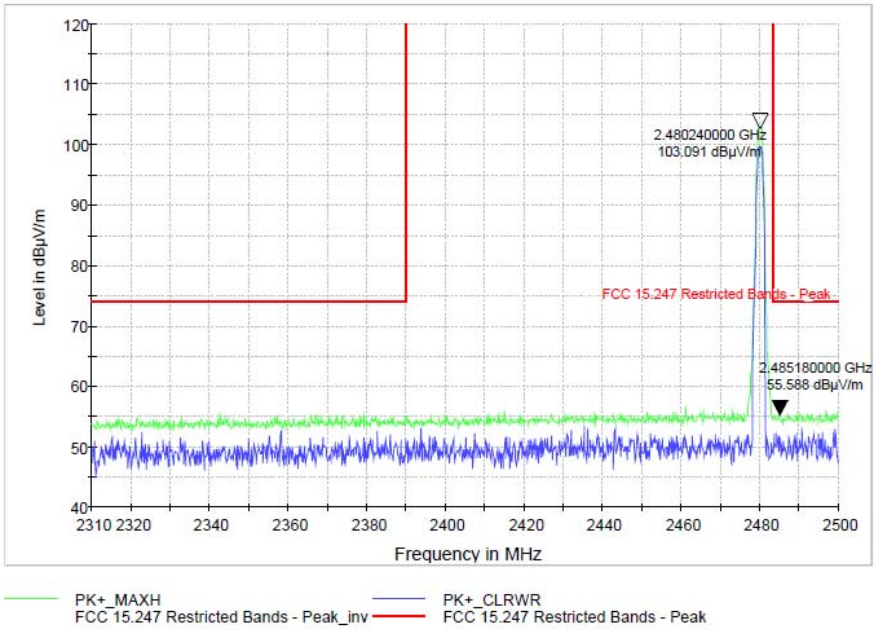

Figure 9-5533 Radiated Restricted Band Edge (Ch. 39) Peak 1MHz BW

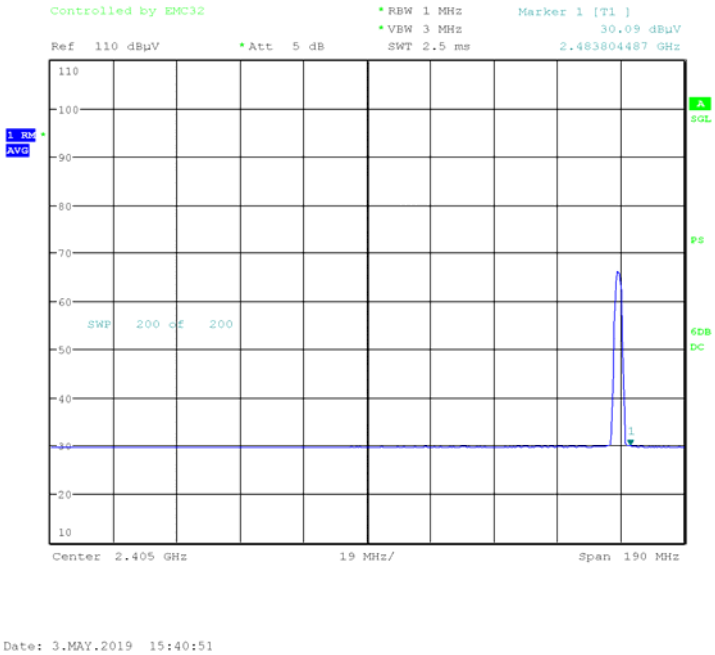

Figure 9-5634 Radiated Restricted Band Edge (Ch. 39) Average 1MHz BW

Band edge Average Data								
Carrier Frequency (MHz)	Bandwidth (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)
2402	2	2389.6	29.79	12.7	5.04	47.44	54	-6.56
2480	2	2483.8	30.11	12.7	5.04	47.85	54	-6.15
2402	1	2389.6	29.79	12.7	2.23	44.72	54	-9.28
2480	1	2483.8	30.09	13.2	2.23	45.52	54	-8.48

9.8.5.2 Emissions in 30 MHz- 1 GHz range

All channels were tested and worst-case results from channel 39 for 1MHz and 2MHz bandwidths shown here.

RSE 30-1000 MHz							
Carrier Frequency (MHz)	Bandwidth (MHz)	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)
2480	2	348.86	-2.12	23.0	20.88	46	-25.12
2480	2	406.12	2.85	24.7	27.55	46	-18.45
2480	2	679.87	7.67	29.8	37.47	46	-8.53
2480	2	705.26	0.18	30.3	30.48	46	-15.52
2480	1	384.85	5.93	24.0	29.93	46	-16.07
2480	1	679.90	7.96	29.8	37.76	46	-8.24
2480	1	962.17	-0.75	33.4	32.65	54	-21.35

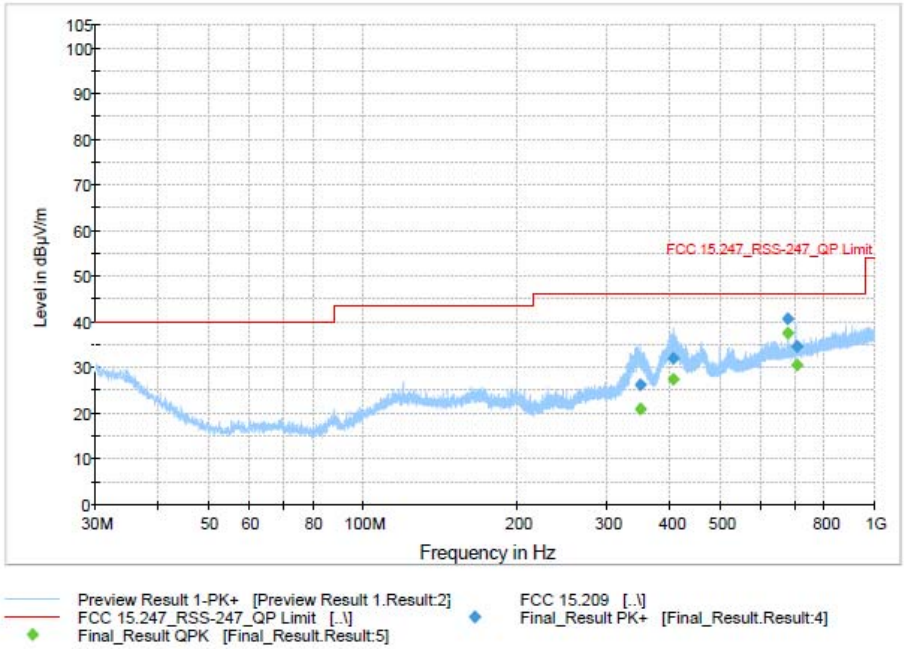

Figure 9-57 Radiated Spurious Emissions (Ch. 39) 2480 (30MHz - 1GHz) 2MHz BW

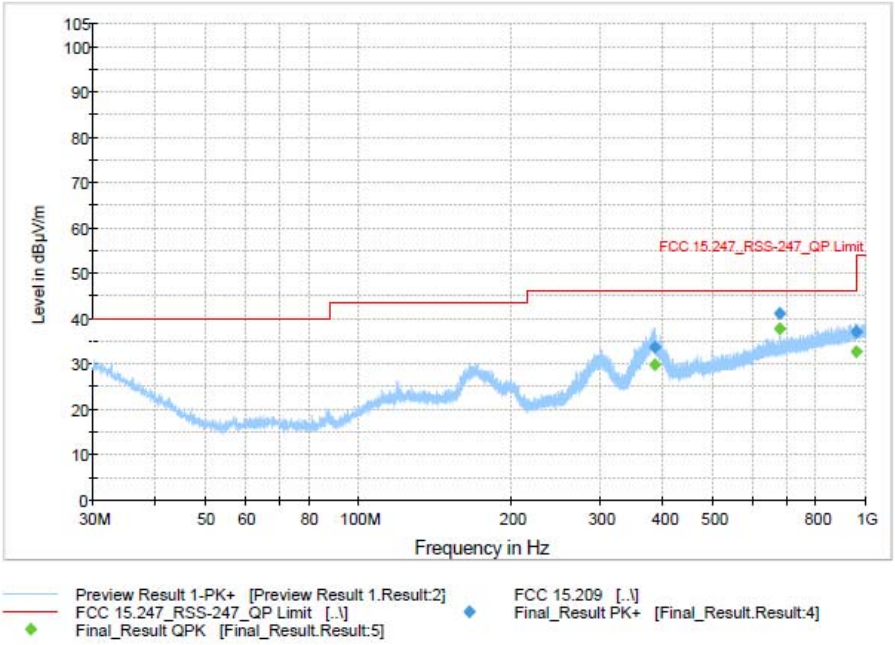

Figure 9-58 Radiated Spurious Emissions (Ch. 39) 2480 (30MHz - 1GHz) 1MHz BW

9.8.5.3 Emissions in 1-18 GHz range

RSE 1 - 18GHz Average Data								
Carrier Frequency (MHz)	**Bandwidth (MHz)**	**Frequency (MHz)**	**Raw Avg. Amplitude (dBµV)**	**Correction Factor (dB)**	**DC Correction Factor (dB)**	**Corrected Avg. Field Strength (dBµV/m)**	**Average Limit (dBµV/m)**	**Margin (dB)**
2402	1	3399.7	26.35	5.0	0	31.35	54	-22.65
2402	1	9868.0	25.85	13.9	0	39.75	54	-14.25
2402	1	17790.9	20.56	19.9	0	40.46	54	-13.54
2440	1	9868.0	28.88	13.9	0	42.78	54	-11.22
2440	1	17797.8	20.69	20.0	0	40.69	54	-13.31
2480	1	9868.0	27.44	13.9	0	41.34	54	-12.66
2480	1	17975.4	20.29	21.1	0	41.39	54	-12.61
2402	2	3399.9	26	5.0	0	31	54	-23.00
2402	2	6960.0	30.53	9.8	0	40.33	54	-13.67
2402	2	7680.0	24.94	11.1	0	36.04	54	-17.96
2440	2	3399.8	25.91	5.0	0	30.91	54	-23.09
2440	2	6960.0	30.7	9.8	0	40.5	54	-13.50
2440	2	17860.6	20.48	20.7	0	41.18	54	-12.82
2480	2	3400.0	26.14	5.0	0	31.14	54	-22.86
2480	2	6960.0	30.75	9.8	0	40.55	54	-13.45
2480	2	17799.0	19.9	20.4	0	40.3	54	-13.70

RSE 1 - 18GHz Peak Data							
Carrier Frequency (MHz)	Bandwidth (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
2402	1	3399.3	37.4	5.0	42.40	74	-31.60
2402	1	9868.0	34.24	13.9	48.14	74	-25.86
2402	1	17834.4	32.15	20.2	52.35	74	-21.65
2440	1	9872.4	32.79	14.0	46.79	74	-27.21
2440	1	17803.5	32.37	20.0	52.37	74	-21.63
2480	1	9868.0	36.74	13.9	50.64	74	-23.36
2480	1	17975.4	20.29	21.1	41.39	74	-21.54
2402	2	3398.1	36.93	5.0	41.93	74	-32.07
2402	2	6960.0	37.97	9.8	47.77	74	-26.23
2402	2	7686.9	32.99	11.1	44.09	74	-29.91
2440	2	3438.4	35.66	4.9	40.56	74	-33.44
2440	2	6960.0	37.19	9.8	46.99	74	-27.01
2440	2	17877.4	31.68	21.0	52.68	74	-21.32
2480	2	3400.7	36.25	5.0	41.25	74	-32.75
2480	2	6960.1	37.63	9.8	47.43	74	-26.57
2480	2	17839.4	31.63	20.4	52.03	74	-21.97

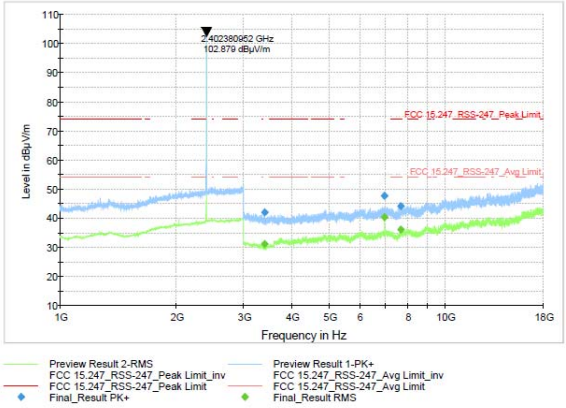

Figure 9-59 Radiated Spurious Emissions 1-18 GHz (Ch. 0) BW 2-MHz

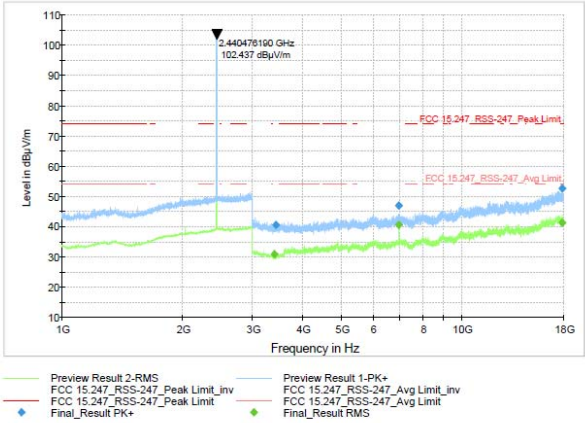

Figure 9-60 Radiated Spurious Emissions 1-18 GHz (Ch. 19) BW 2-MHz

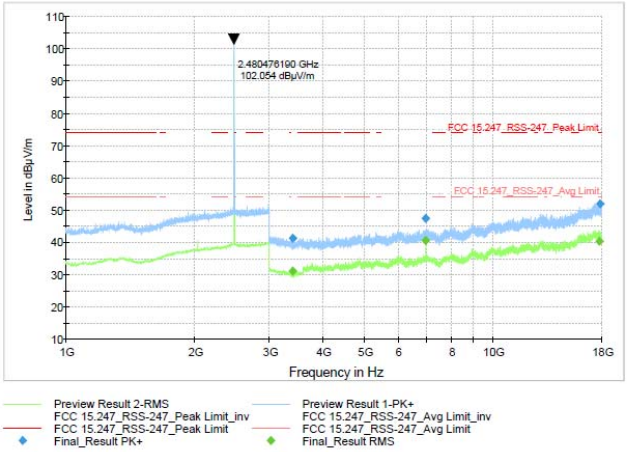

Figure 9-61 Radiated Spurious Emissions 1-18 GHz (Ch. 39) BW 2-MHz

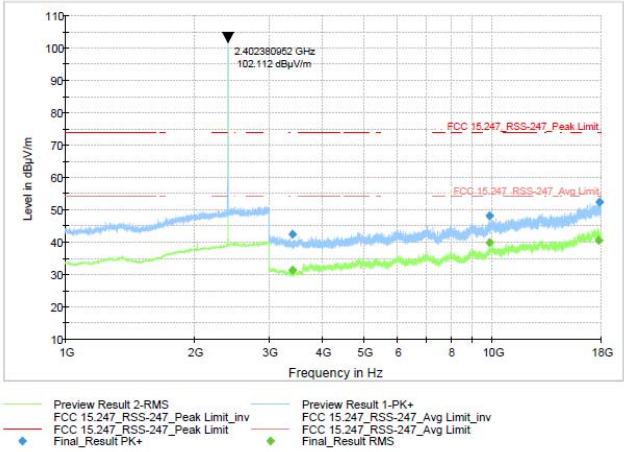

Figure 9-62 Radiated Spurious Emissions 1-18 GHz (Ch. 0) BW 1-MHz

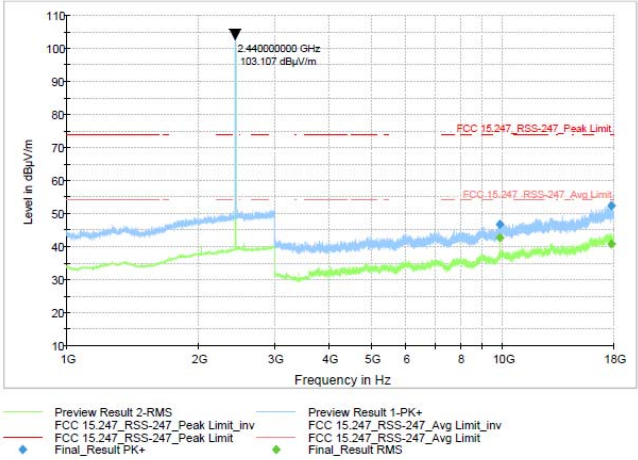

Figure 9-63 Radiated Spurious Emissions 1-18 GHz (Ch. 19) BW 1-MHz

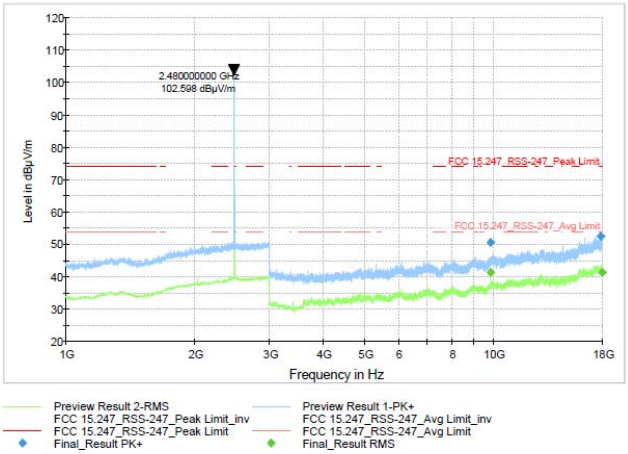

Figure 9-64 Radiated Spurious Emissions 1-18 GHz (Ch. 39) BW 1-MHz

9.8.5.4 Emissions in 18-26.5 GHz range

All channels were tested and worst-case results from channel 39 (2480 MHz) shown here.
No significant emissions to report above noise floor.

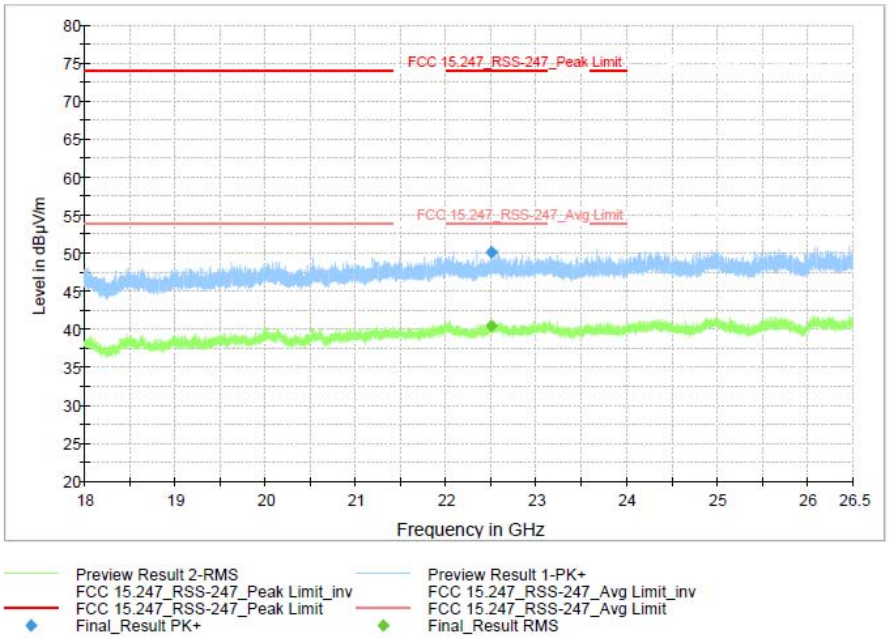

Figure 9-65 Radiated Spurious Emissions (Ch. 39) (18 – 26.5 GHz) BW 2MHz

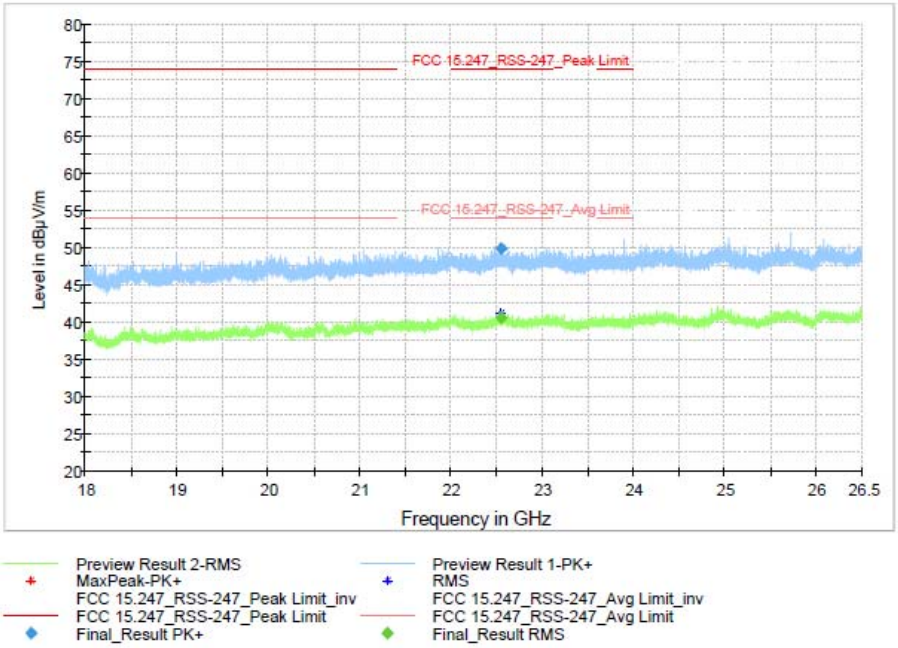

Figure 9-66 Radiated Spurious Emissions (Ch. 39) (18 – 26.5 GHz) BW 1MHz

9.9 AC Line Conducted Emissions

9.9.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)

ISED RSS Gen [8.8]

9.9.2 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 is set to continuously transmit on Ch.39.

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

9.9.3 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

9.9.4 Test Result:

Pass

9.9.5 Test Data:

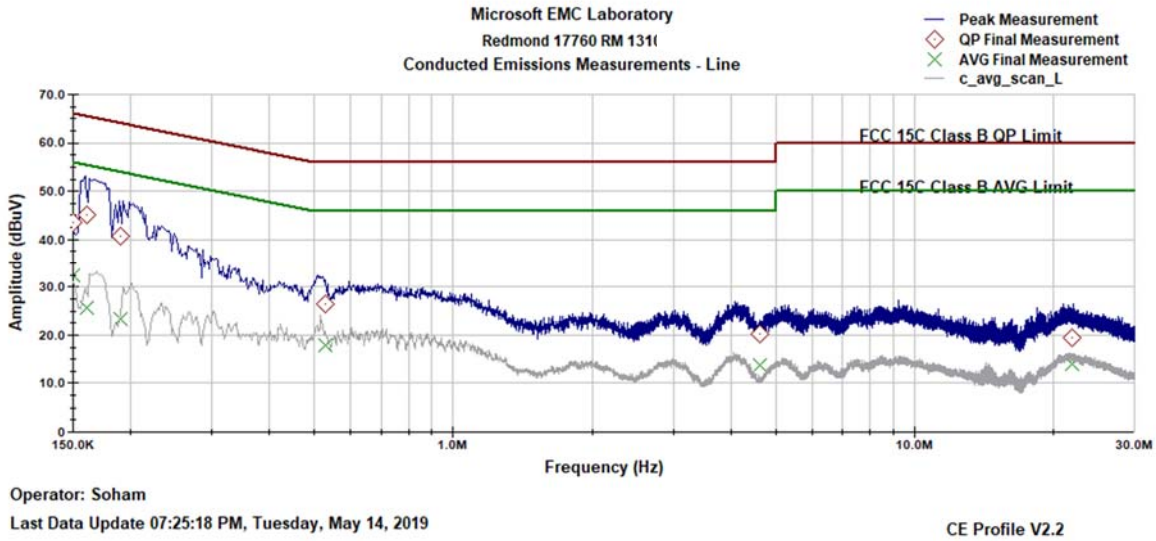

Figure 9-67 AC Line Conducted Emissions- Line (150 kHz- 30 MHz)

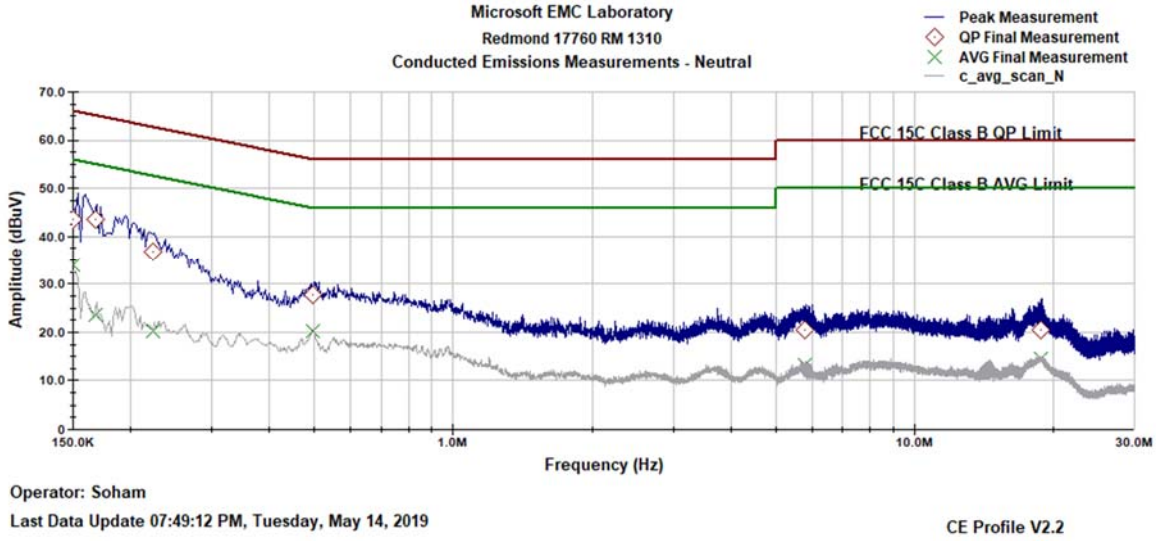

Figure 9-68 AC Line Conducted Emissions- Neutral (150 kHz- 30 MHz)

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)
0.168	43.45	23.70	65.05	55.05	N	-21.60	-31.35
0.150	43.56	33.94	65.99	55.99	N	-22.43	-22.05
0.224	36.87	20.33	62.68	52.68	N	-25.81	-32.35
0.495	27.71	20.13	56.08	46.08	N	-28.37	-25.95
18.765	20.44	14.49	60.00	50.00	N	-39.56	-35.52
5.774	20.36	13.16	60.00	50.00	N	-39.64	-36.84
0.161	45.16	25.53	65.40	55.40	L	-20.25	-29.87
0.150	43.53	32.46	65.99	55.99	L	-22.47	-23.53
0.190	40.76	23.21	64.02	54.02	L	-23.26	-30.82
0.528	26.54	17.90	56.00	46.00	L	-29.46	-28.10
4.630	20.26	13.62	56.00	46.00	L	-35.75	-32.38
21.910	19.35	14.06	60.00	50.00	L	-40.65	-35.94

End of Report