RADIO TEST REPORT

For

MODEL NO.: 1708
FCC ID: C3K1708
IC ID: 3048A-1708

Test Report No. R-TR727-1708-FCCISED-BTLE-2
Issue Date: September 16th, 2021

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

Prepared by
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A2LA ACCREDITED
TESTING CERT #3472.01

1 Record of Revisions

Revision	Date	Section	Page(s)	Summary of Changes	Author/Revised By:
1.0	9/3/2021	All	All	Version 1.0	Pooja Akhoury
2.0	9/16/2021	3.2 5	7 8	Added ISED CAB ID under accreditation Added BTLE data rate	Pooja Akhoury

Contents

Test Report Attestation

Microsoft Corporation
Model: 1708
FCC ID: C3K1708
IC ID: 3048A-1708

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.

Written By: Pooja Akhoury

RF Test Engineer

Reviewed/ Issued By: Daniel Salinas

RF 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: 26315
ISED CAB ID: US0212

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 1 GHz)	5.99	dB
Radiated disturbance (1 GHz to 40 GHz)	5.12	dB
Conducted Disturbance at Mains Port	3.31	dB
Uncertainty for Conducted Power test	1.277	dB
Uncertainty for Conducted Spurious emission test	2.742	dB
Uncertainty for Bandwidth test	4.98	kHz
Uncertainty for DC power test	0.05	%
Uncertainty for test site temperature	0.5	ºC
Uncertainty for test site Humidity	3	%
Uncertainty for time	0.189	%

5 Product Description

Company Name:	Microsoft Corporation
Address:	One Microsoft Way
City, State, Zip:	Redmond, WA 98052-6399
Customer Contact:	Vishwas Narayan
Functional Description of the EUT:	Wireless Input device with 802.11 g/a/n 20 MHz Accessory, and Bluetooth Low Energy Radios
Model:	1708
FCC ID:	C3K1708
IC ID:	3048A-1708
Radio under test:	BTLE (2402- 2480 MHz)
Modulation(s)/Data rate:	GFSK/1Mbps
Antenna Information:	Integral Antenna. **Manufacturer declared max Antenna Gain in 2.4GHz band of operation:** 0 Bi
EUT Classification:	DTS
Equipment Design State:	Prototype/Production Equivalent (DV)
Equipment Condition:	Good
Test Sample Details:	**RF Conducted Test Sample-** **Sample ID: R-727-C-DV-02 S/N: 02600367115637** **RF Radiated Test Sample-** **Sample ID: R-727-C-DV-01 S/N: 02600369235637**

5.1 Test Configurations

Test software COM - WCN Combo Tool. Version: W1509 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 39 were used as Low, Mid and High Channels respectively.

5.2 Environmental Conditions

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

5.3 Antenna Requirements

The antennas are permanently attached and there are no provisions for connection to an external antenna.

5.4 Equipment Modifications

No modifications were made during testing.

5.5 Dates of Testing

Testing was performed from May 14th,2021 to June 14th,2021.

5.6 Test Engineers:

Test Case	Test Engineers
Radiated	Akshay Landge Farrah Saad
Conducted	Vishwas Narayan

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-229	4/3/2022
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-192	3/31/2022
Keysight	Spectrum Analyzer	N9020B	RF-996	10/25/2021
Rohde & Schwarz	Open Switch and Control	OSP130	RF-193	N/A
Rohde & Schwarz	Open Switch and Control	OSP150	RF-194	N/A
Rohde & Schwarz	Open Switch and Control	OSP130	RF-018	N/A
Rohde & Schwarz	Open Switch and Control	OSP150	RF-019	N/A
Rohde & Schwarz	Custom Filter Bank	SFUNIT RX	RF-324	N/A
Rohde & Schwarz	Preamplifier	TS-PR26	RF-042	N/A
Sunol Sciences	Antenna - Broadband	JB6	RF-039	1/13/2022
ETS-Lindgren	Antenna - Double-Ridged	3117	RF-137	8/12/2021
ETS-Lindgren	Antenna - Standard Gain	3160-09	EMC-452	1/13/2022
Huber & Suhner	RF Cable	SucoFlex 100	RF-430	11/12/2021
Teledyne	RF Cable	PR90-195-276	RF-1286	N/A
Micro-Coax	RF-Cable	UFB311A-1-0787-50U50U	RF-1211	N/A
Micro-Coax	RF Cable	UTI Flex	RF-1210	N/A
Micro-Coax	RF Cable	UTI Flex	RF-359	N/A
Micro-Coax	RF Cable	UFB311A-1-0787-50U50U	EMC-351	N/A
MegaPhase	RF Cable	EMC3-N1N1-394	RF-1036	N/A
Pasternack	Attenuator	PE7004-6	EMC-949	1/13/2022
MCL	Attenuator	BHBW-S6-2W263+	RF-710	N/A

MadgeTech	Environmental Meter	PRHTemp2000	EMC-678	1/29/2022
MadgeTech	Environmental Meter	PRHTemp2000	EMC-879	7/16/2021

Equipment used for Line Conducted Emissions Measurement				
Manufacturer	**Description**	**Model #**	**Asset #**	**Calibration Due**
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-604	2/23/2022
Teseq	Test LISN	NNB 051	EMC-1197	9/30/2021
Micro-Coax	RF Cable	UFA210A-1-1800-50U50U	EMC-367	12/11/2021
PCE	THP Monitor	PCE-THB 40	EMC-1205	11/4/2021
ETS Lindgren	TILE SW	Version 7.5.3.5	EMC-984	N/A
Chroma	AC Power source	61602	EMC-055	N/A

Manufacturer	**Description**	**Model #**	**Asset #**	**Calibration Due**
Rohde & Schwarz	EMC 32 Test Software	V10.01.0	N/A	N/A

Note 1: 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 9kHz- 30 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. 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 flat orientation was identified as the worst-case configuration.

8.1.2 Radiated Measurements in 30 MHz - 1000 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. A linearly polarized broadband antenna is positioned at 3m from the EUT periphery. The turntable is rotated 360 degrees, and the antenna height varied from 1m to 4m to determine the highest emissions. This is repeated for both horizontal and vertical polarizations of the measurement antenna. All possible orientations of the EUT were investigated for emissions and the vertical standing orientation was identified as the worst-case configuration.

8.1.3 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

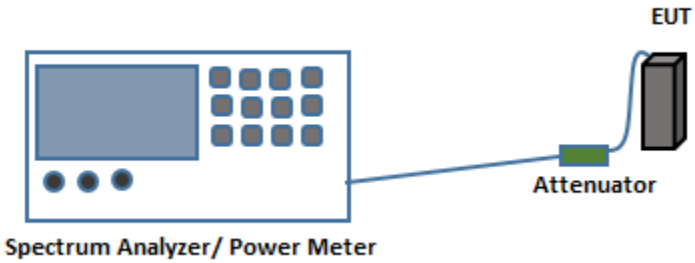

Fig.1. Test Setup for Antenna port conducted measurements

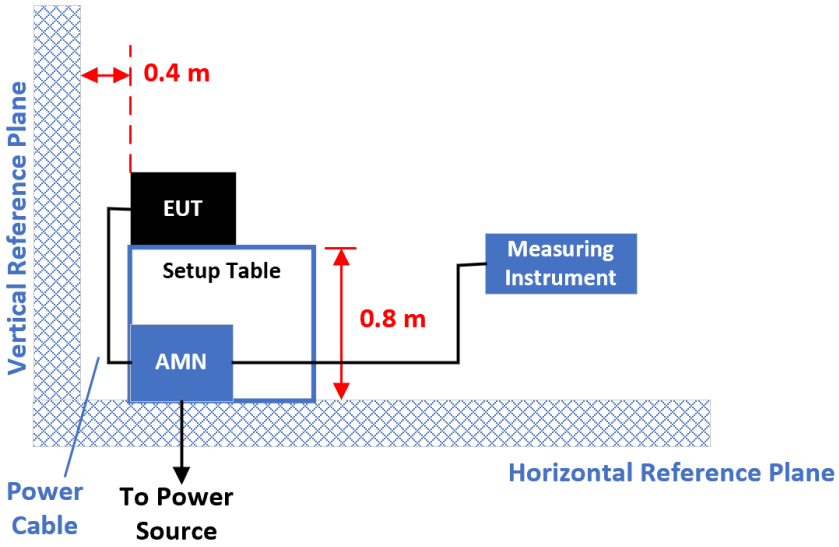

Fig.2. Test Setup for AC Line Conducted Emissions

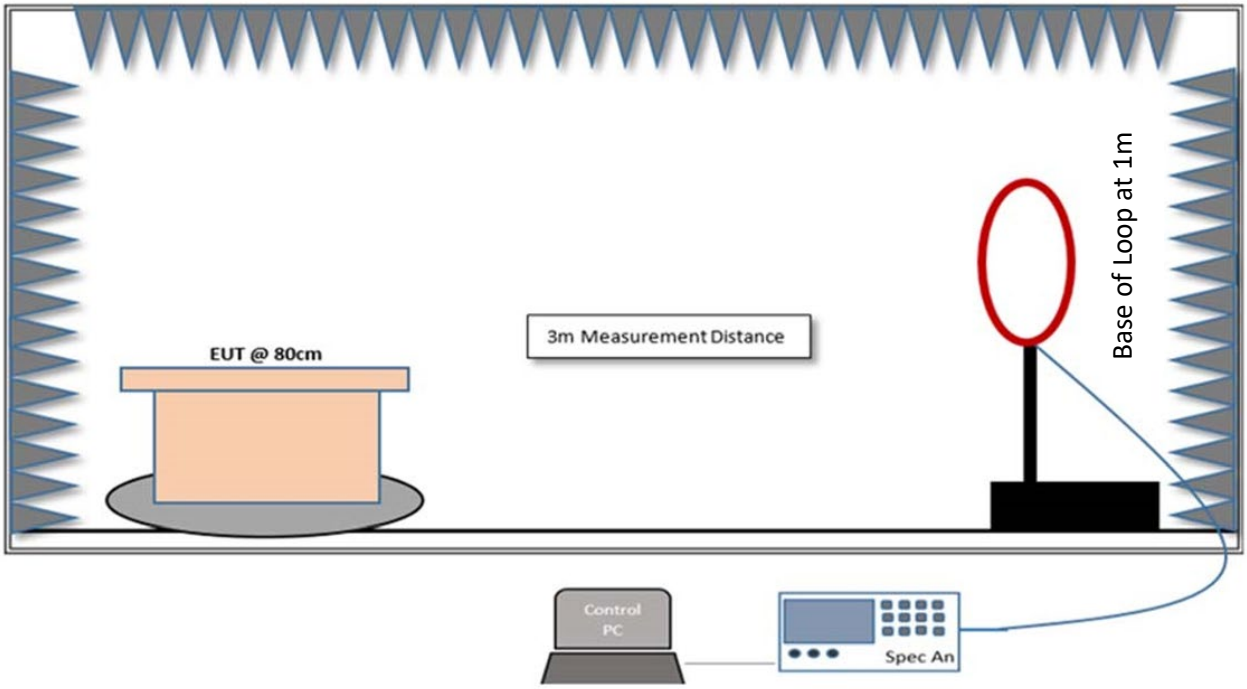

Fig.3. Test Setup for Radiated measurements in 9kHz - 30MHz Range

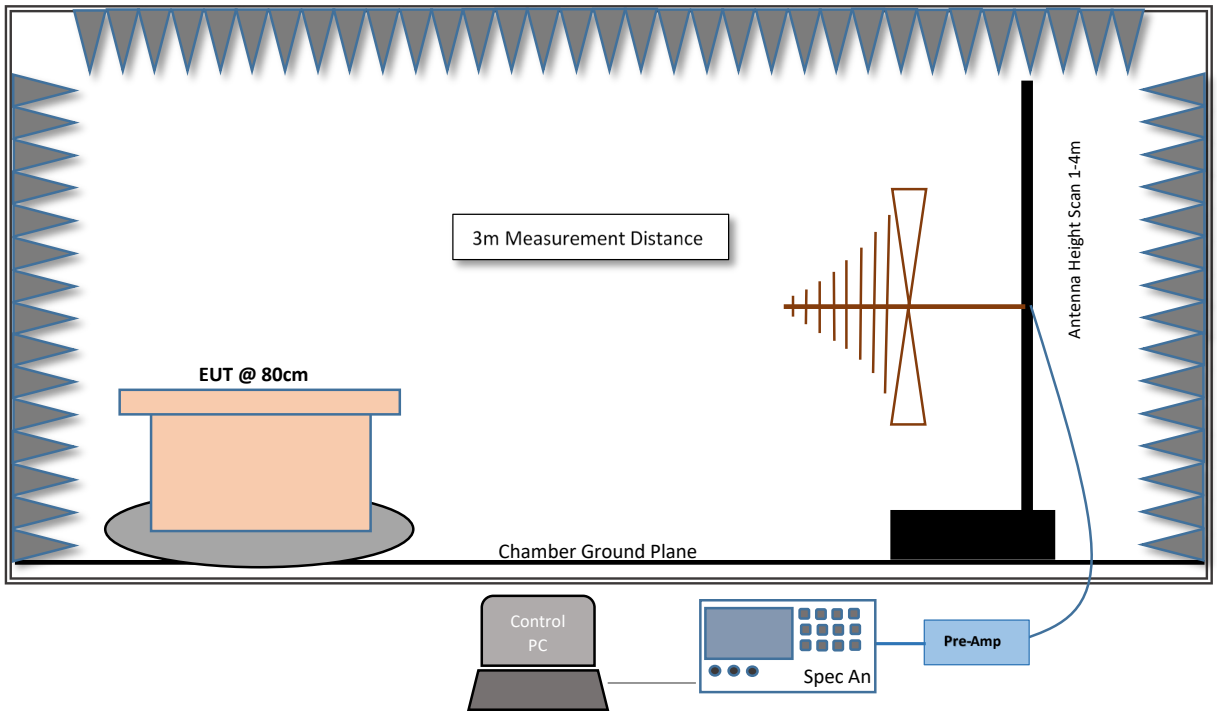

Fig.4.Test Setup for Radiated measurements in 30MHz- 1GHz Range

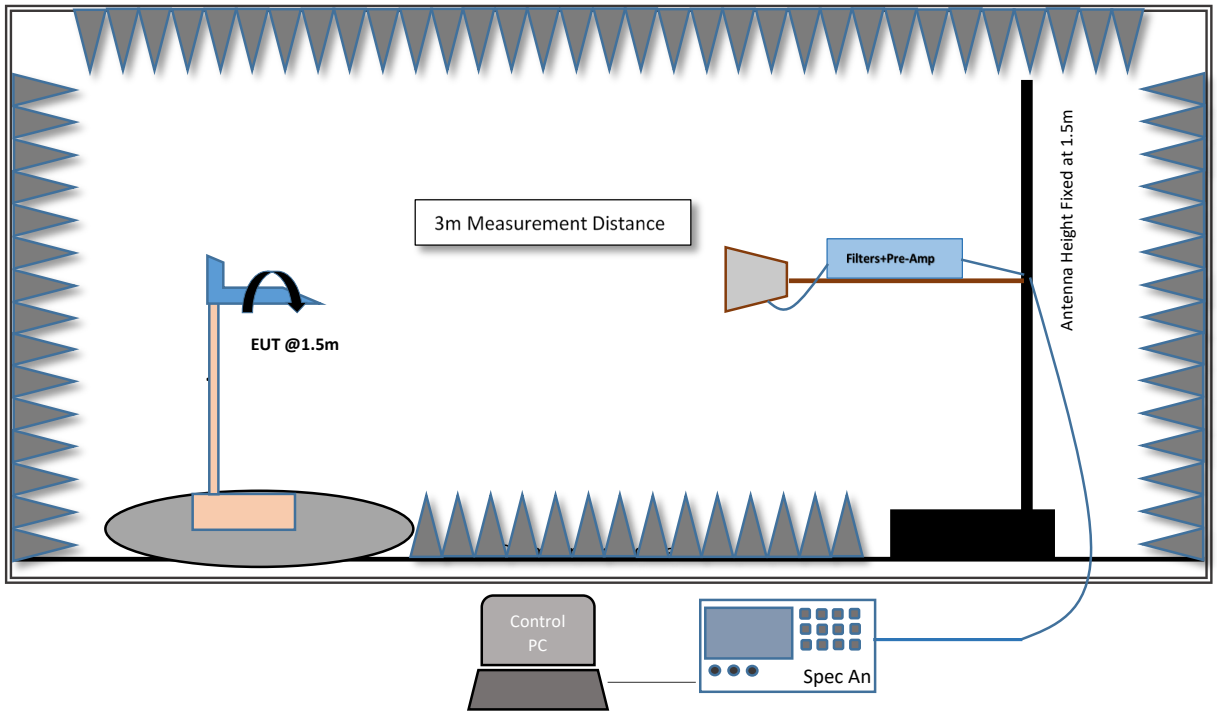

Fig.5. Test Setup for Radiated measurements in 1GHz- 18GHz Range

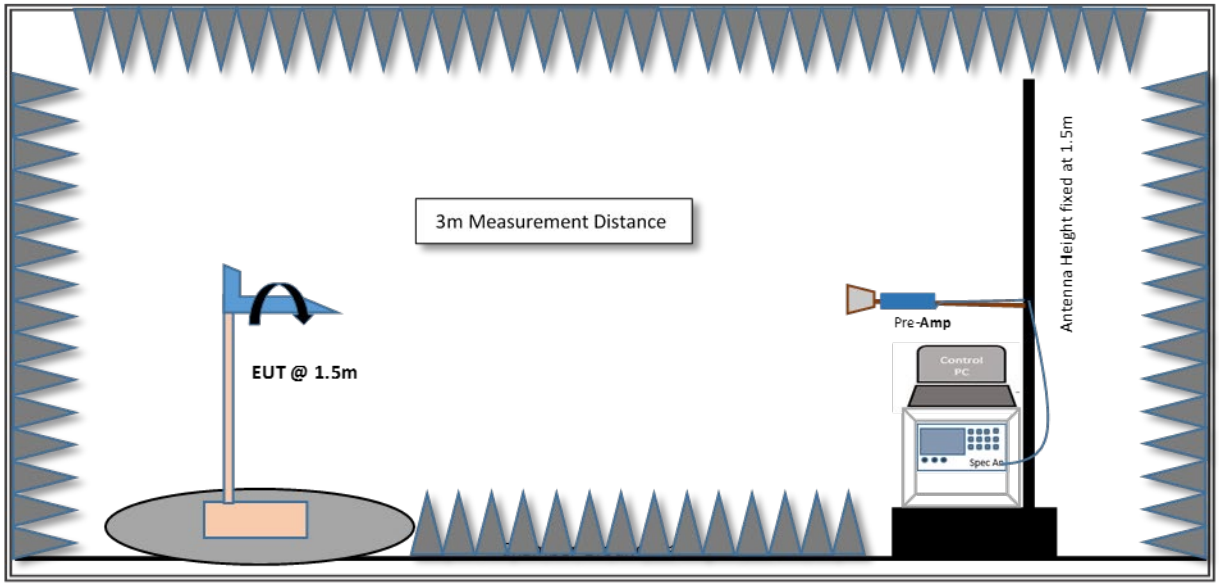

Fig.6. Test Setup for Radiated measurements >18GHz

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

9.1.3 Limits:

Reporting and measurement purposes only.

9.1.4 Test Results:

Frequency (MHz)	On Time (ms)	Period (ms)	Duty Cycle (%)	Correction Factor (dB)
2402	0.377	0.625	60.320	2.195

9.1.5 Test Data:

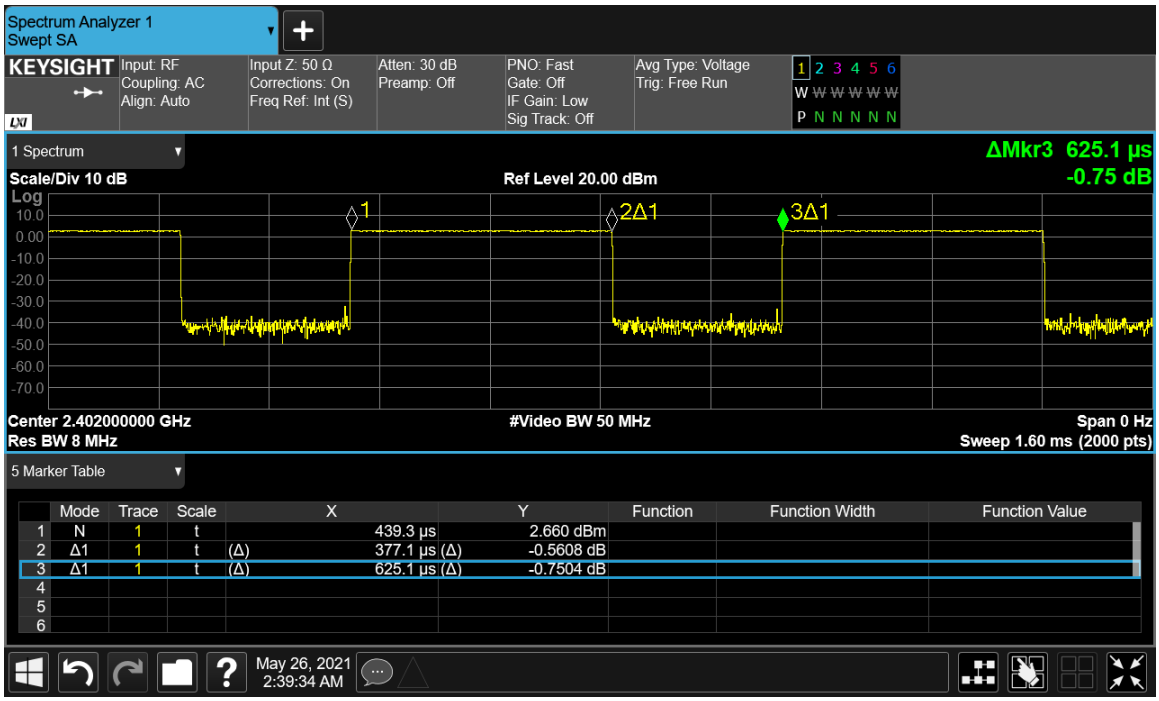

Figure 9-1 Duty Cycle 2440MHz (Ch.0)

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.

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)	Test Mode	Channel No.	6dB Bandwidth (kHz)	Limit (kHz)	Result
2402	BT LE	0	699.8	>500	Pass
2440	BT LE	19	694.1	>500	Pass
2480	BT LE	39	692.3	>500	Pass

9.2.5 Test Data:

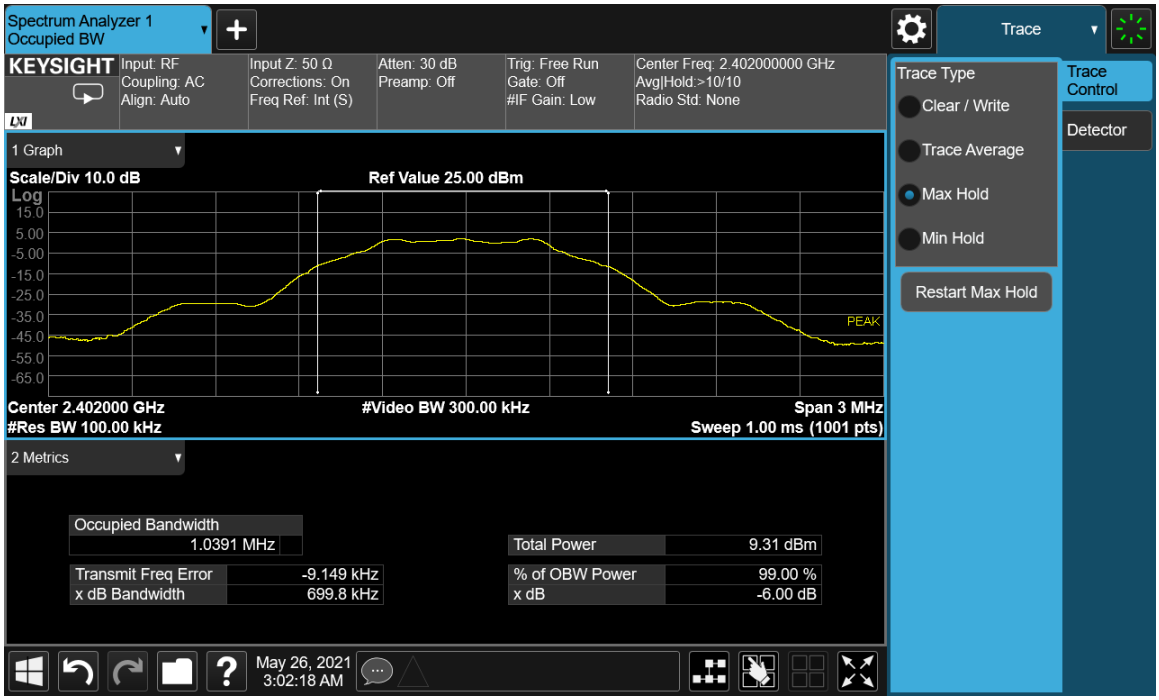

Figure 9-2 6dB Bandwidth (Ch. 0)

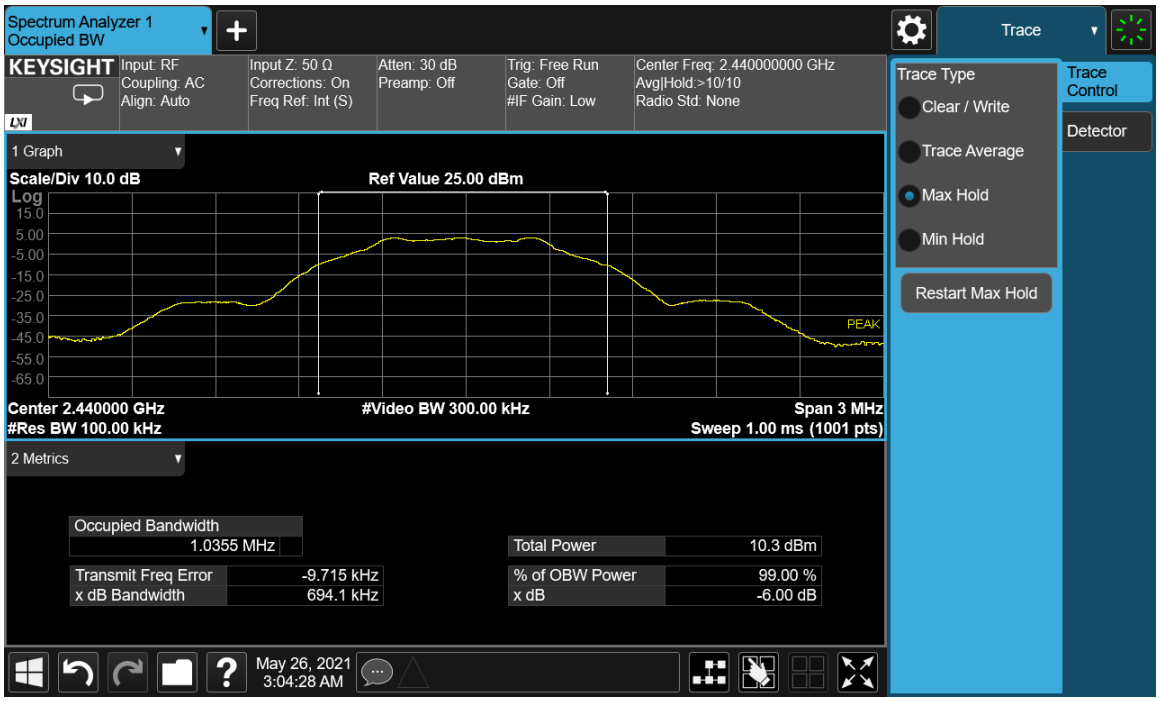

Figure 9-3 6dB Bandwidth (Ch. 19)

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

9.3 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.

9.3.3 Limits:

For reporting purpose only.

9.3.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	99% Bandwidth (MHz)
2402	BT LE	0	1.0251
2440	BT LE	19	1.0235
2480	BT LE	39	1.0227

9.3.5 Test Data:

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

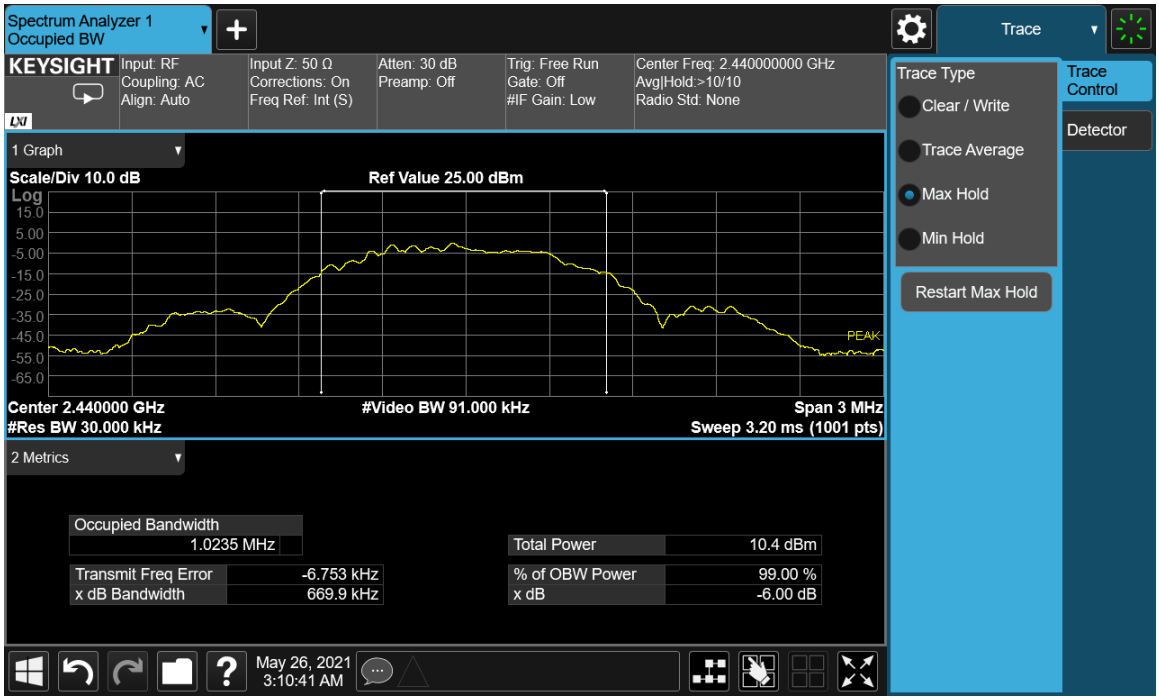

Figure 9-6 99% Bandwidth (Ch. 19)

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

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 Calculation
Output power (dBm) = Raw Value (dBm) + Cable and Attenuator Loss (dB)
i.e., $Output\ Power\ (dBm)$=7.3 dBm+11.7 dB=19 dBm

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)	Mode	Channel No.	Cond. Peak Power (dBm)	Cond. Peak Power (W)	Cond. Peak Limit (dBm)	Margin (dB)	Result
2402	BT LE	0	2.930	0.0020	30	-27.07	Pass
2440	BT LE	19	4.030	0.0025	30	-25.97	Pass
2480	BT LE	39	4.510	0.0028	30	-25.49	Pass

Frequency (MHz)	Mode	Channel No.	Cond. Peak Power (dBm)	Max Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
2402	BT LE	0	2.930	0	2.930	36	-33.07	Pass
2440	BT LE	19	4.030	0	4.030	36	-31.97	Pass
2480	BT LE	39	4.510	0	4.510	36	-31.49	Pass

9.4.5 Test Data:

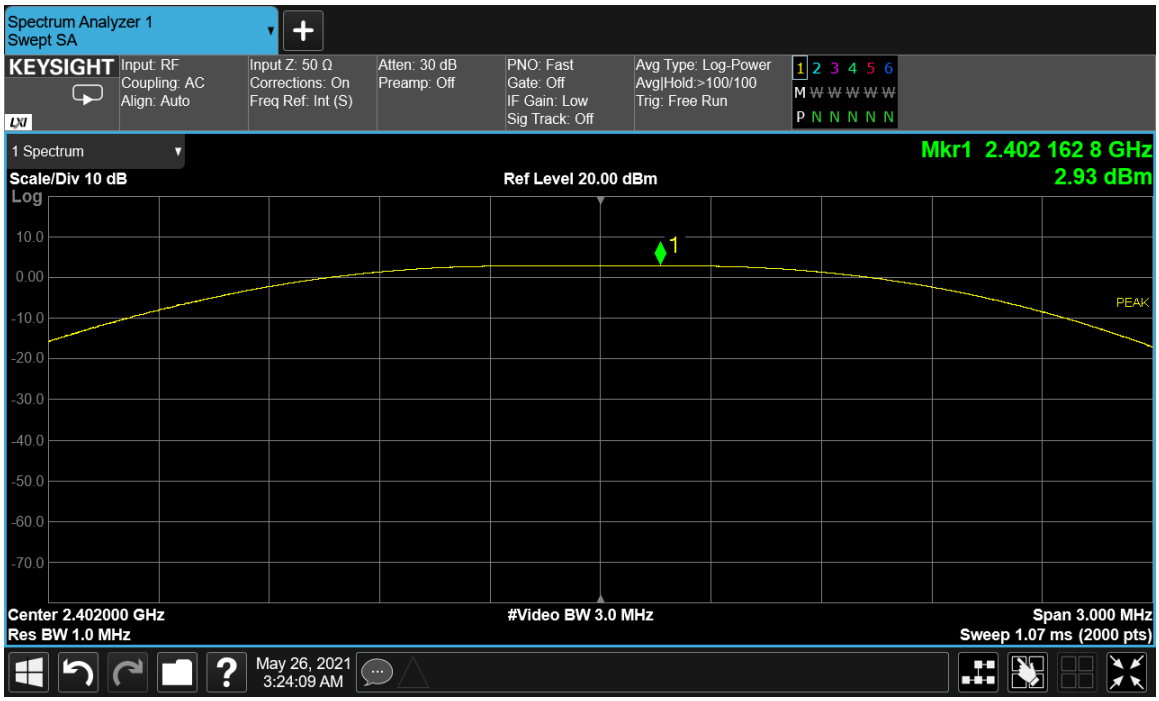

Figure 9-8 Peak Power (Ch. 0)

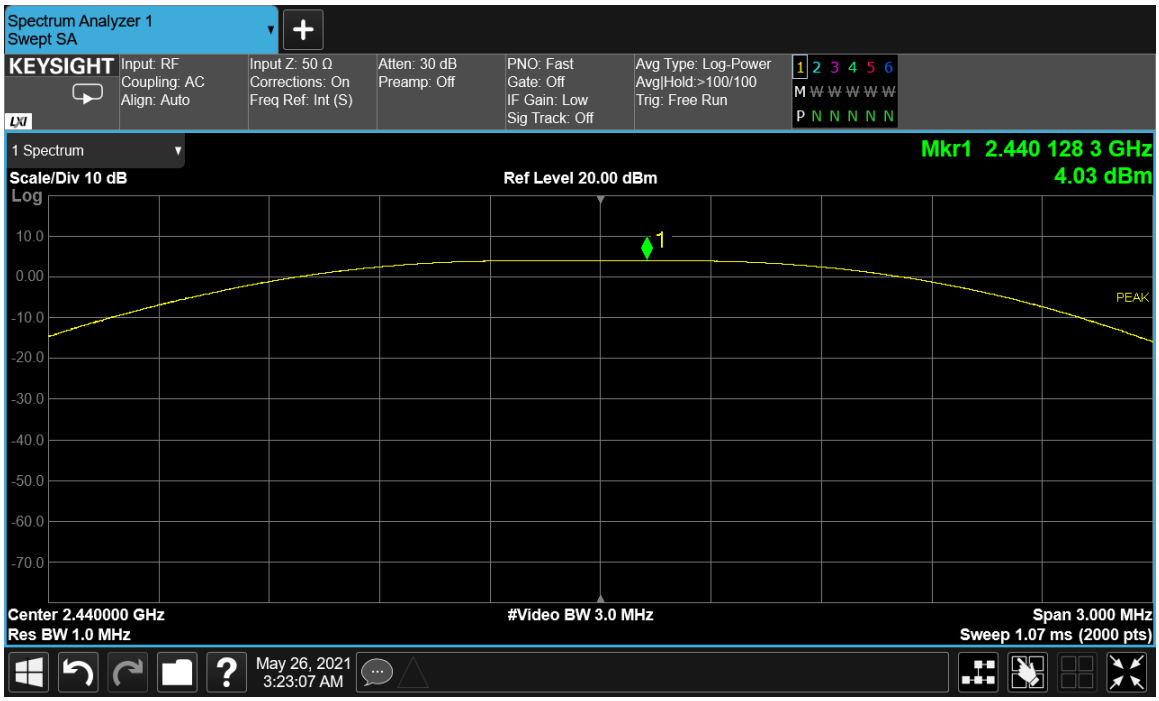

Figure 9-9 Peak Power (Ch. 19)

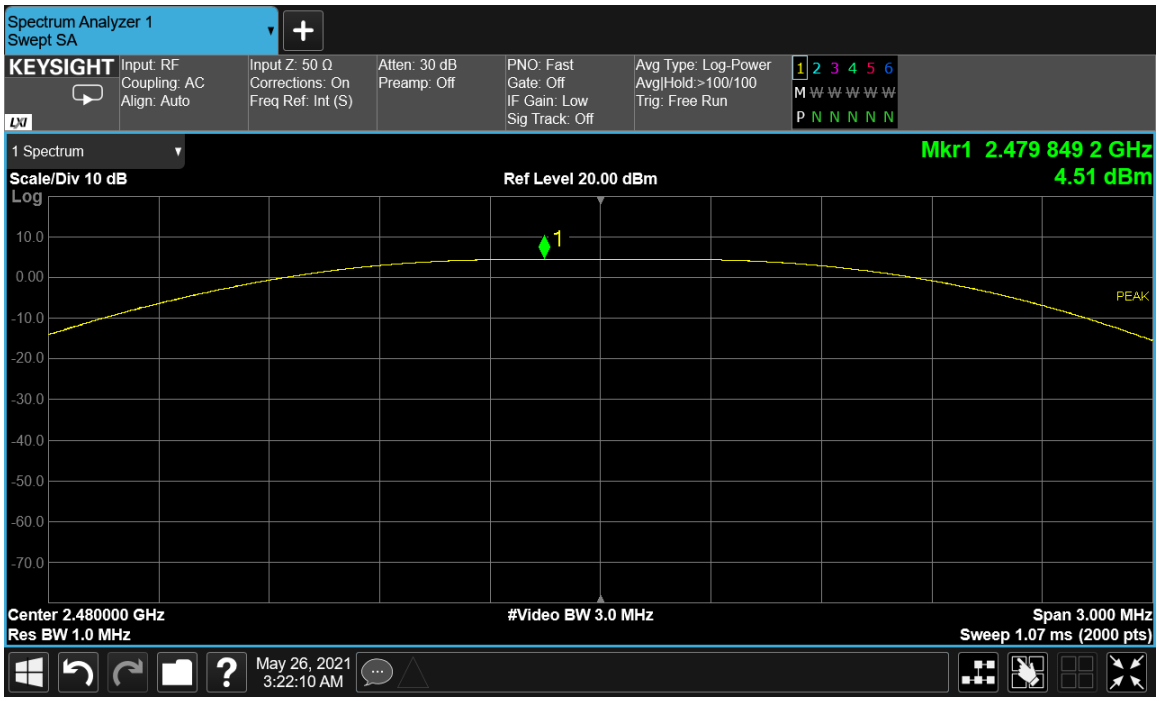

Figure 9-10 Peak Power (Ch. 39)

9.5 Peak Power Density

9.5.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (e)

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 Calculation
Peak Power Density dBm/3kHz = Raw Amplitude (dBm/3kHz) + Cable and Attenuator Loss (dB)

i.e., $Peak\ PSD\ (dBm/3kHz)$ =−5.8 dBm+11.7 dB=5.9 $dBm/3kHz$

9.5.3 Limits:

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

9.5.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	Power Spectral Density (dBm/100kHz)	Limit (dBm/3kHz)	Result
2402	BT LE	0	2.06	8	Pass
2440	BT LE	19	3.15	8	Pass
2480	BT LE	39	3.59	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:

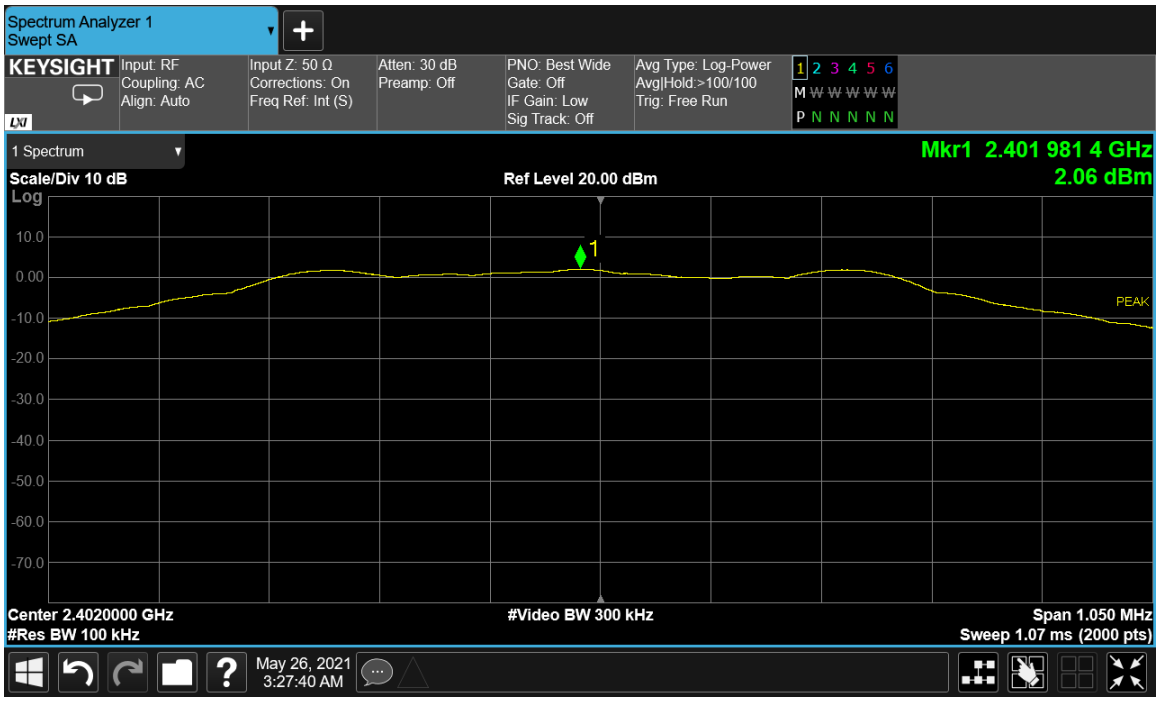

Figure 9-11 Power Spectral Density (Ch. 0)

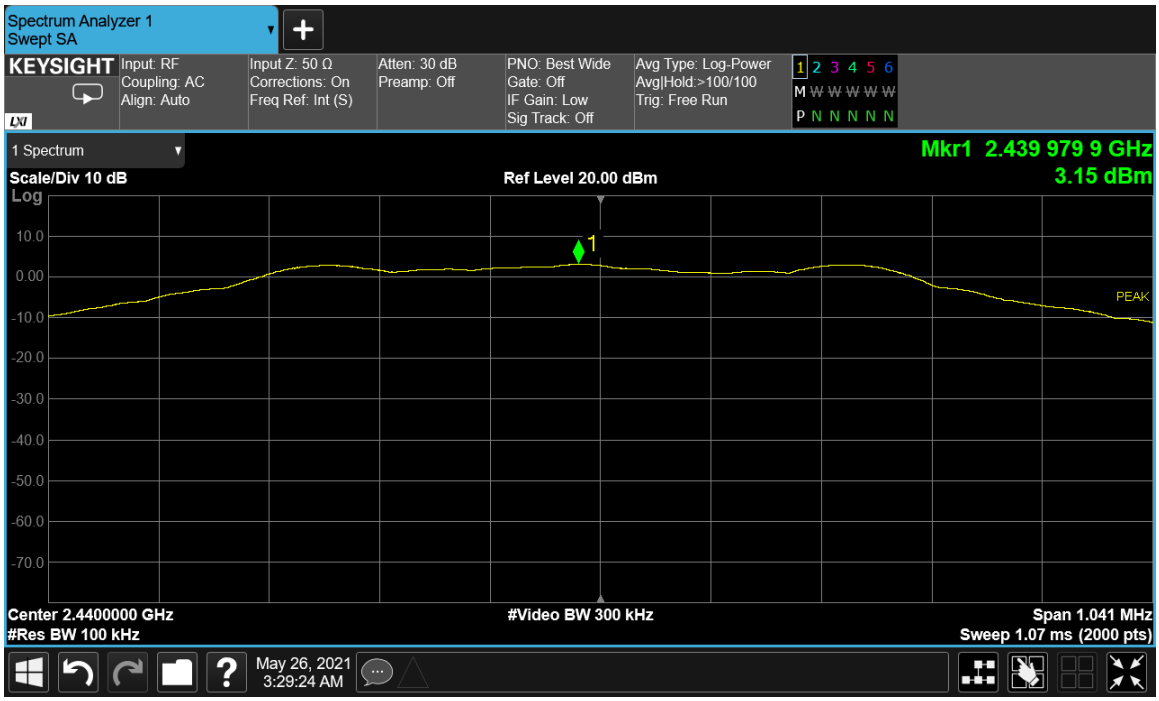

Figure 9-12 Power Spectral Density (Ch. 19)

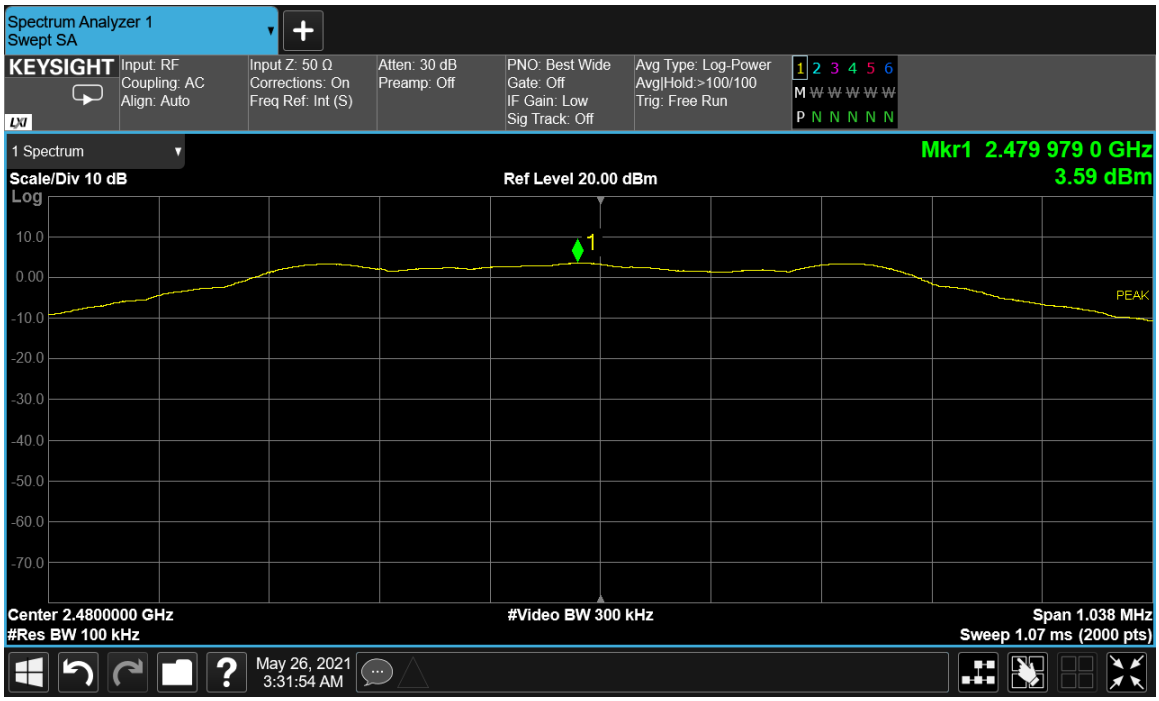

Figure 9-13 Power Spectral Density (Ch. 39)

9.6 Conducted Spurious Emissions

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

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

Emission Level dBm = Raw Amplitude (dBm) + Cable and Attenuator Loss (dB)

i.e., $Emissions\ Level\ (dBm) = -20\ dBm + 14.2\ dB = -5.8\ dBm$

dBc level = Reference Level (dBm/100kHz) – Emission Level (dBm/100kHz)

i.e., $dBc = 17\ dBm - (-5.8)\ \mathrm{dB} = 22.8\ dBc$

9.6.3 Limits:

All spurious emissions at least 20 dBc.

9.6.4 Test Result:

Channel	Carrier Frequency (MHz)	Emission Frequency (MHz)	Emissions Amplitude (dBm/MHz)	Limit (dBm)	Margin (dB)	Result
0	2402	4803.8	-51.57	-17.94	-33.63	Pass
0	2402	4879.6	-50.87	-16.85	-34.02	Pass
19	2440	4960.2	-52.45	-16.41	-36.04	Pass
19	2440	24772.5	-43.35	-17.94	-25.41	Pass
39	2480	24865.2	-42.75	-16.85	-25.90	Pass
39	2480	24905.1	-42.56	-16.41	-26.15	Pass

9.6.5 Test Data:

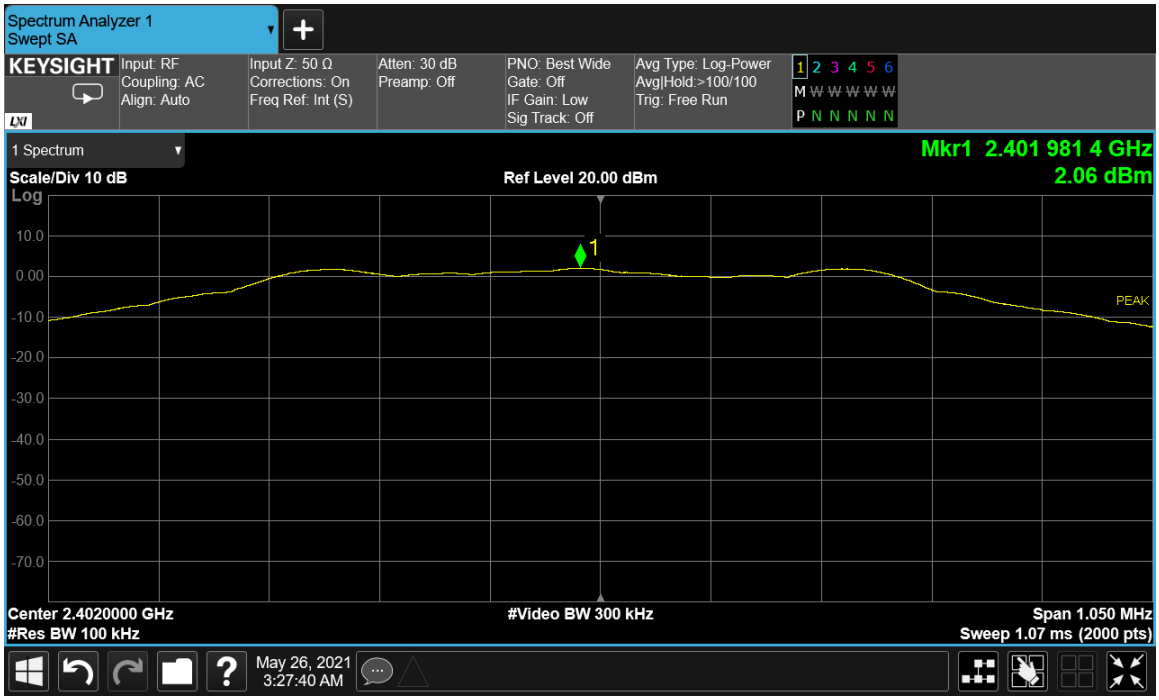

Figure 9-14 Reference Level Measurement (Ch.0)

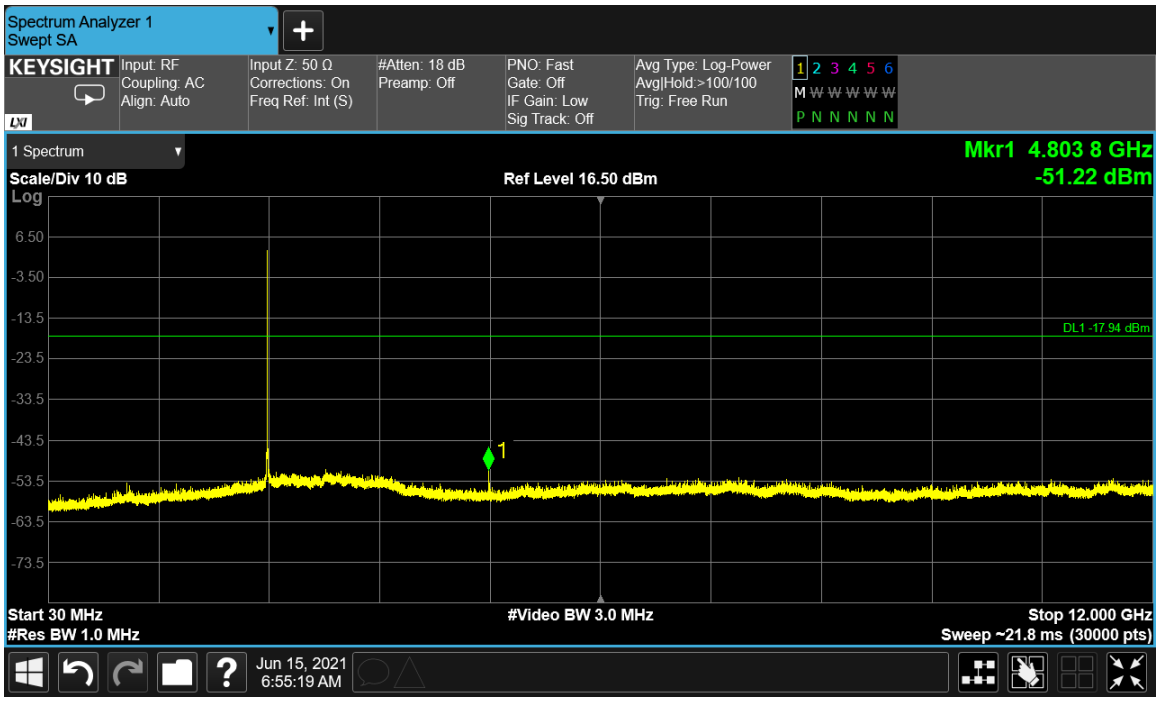

Figure 9-15 Conducted Spurious Emissions 30-12000 MHz (Ch. 0)

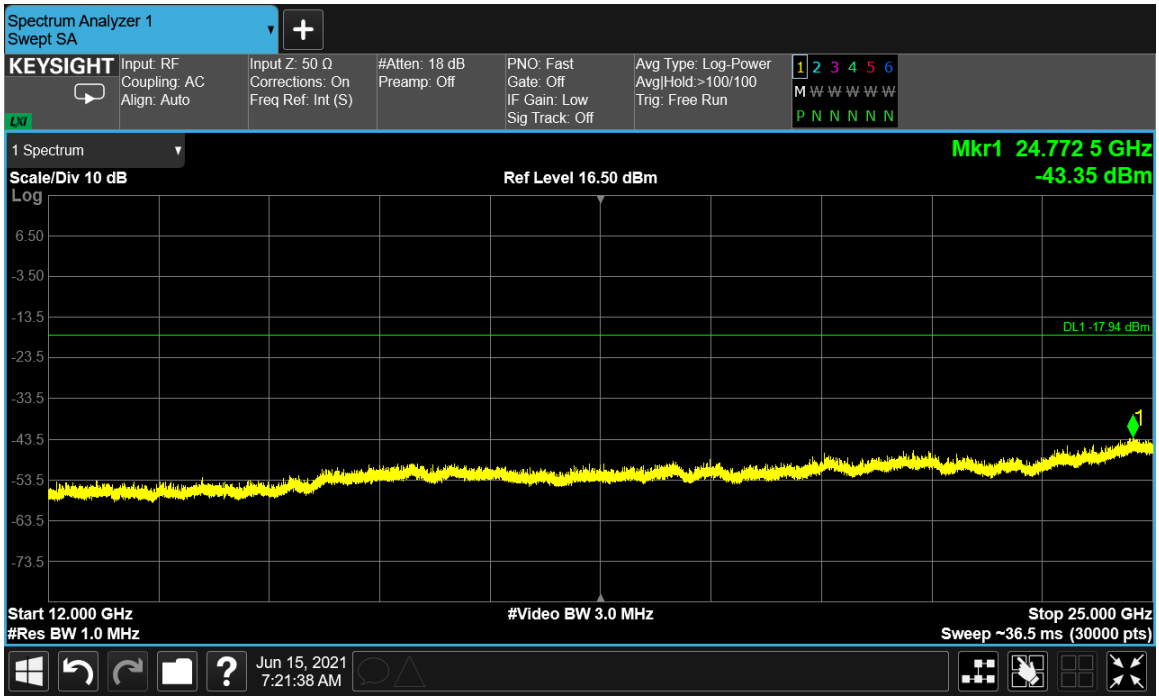

Figure 9-16 Conducted Spurious Emissions 12-25 GHz (Ch.0)

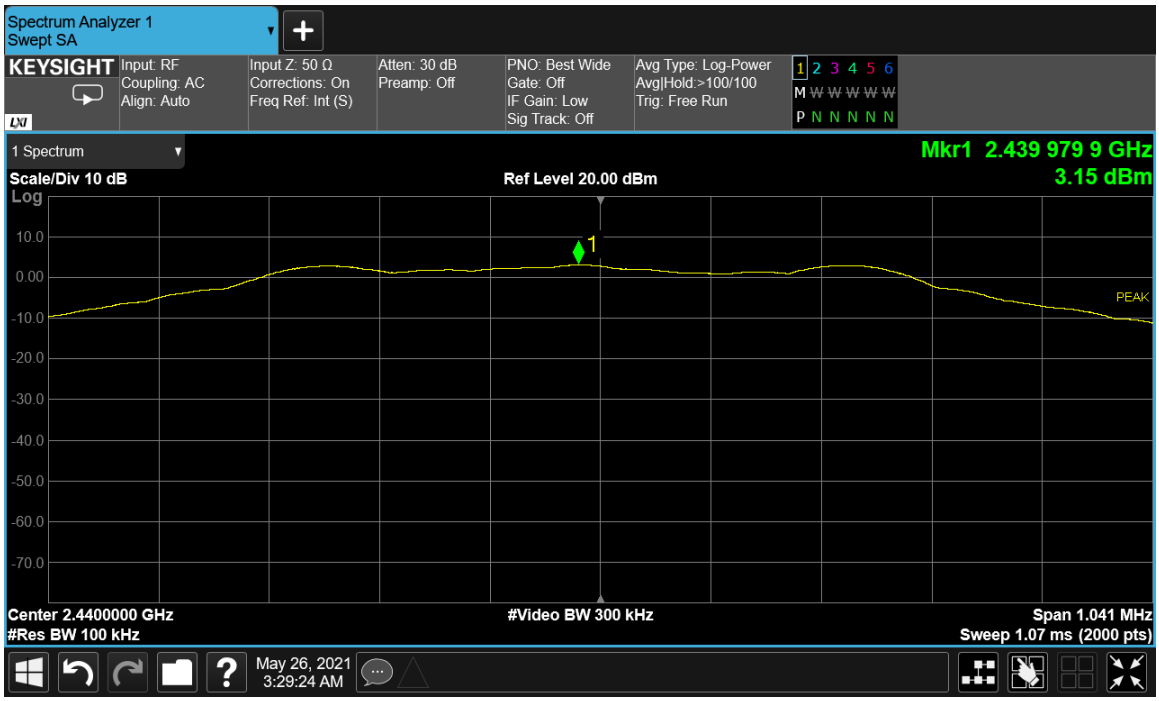

Figure 9-17 Reference Level Measurement (Ch.19)

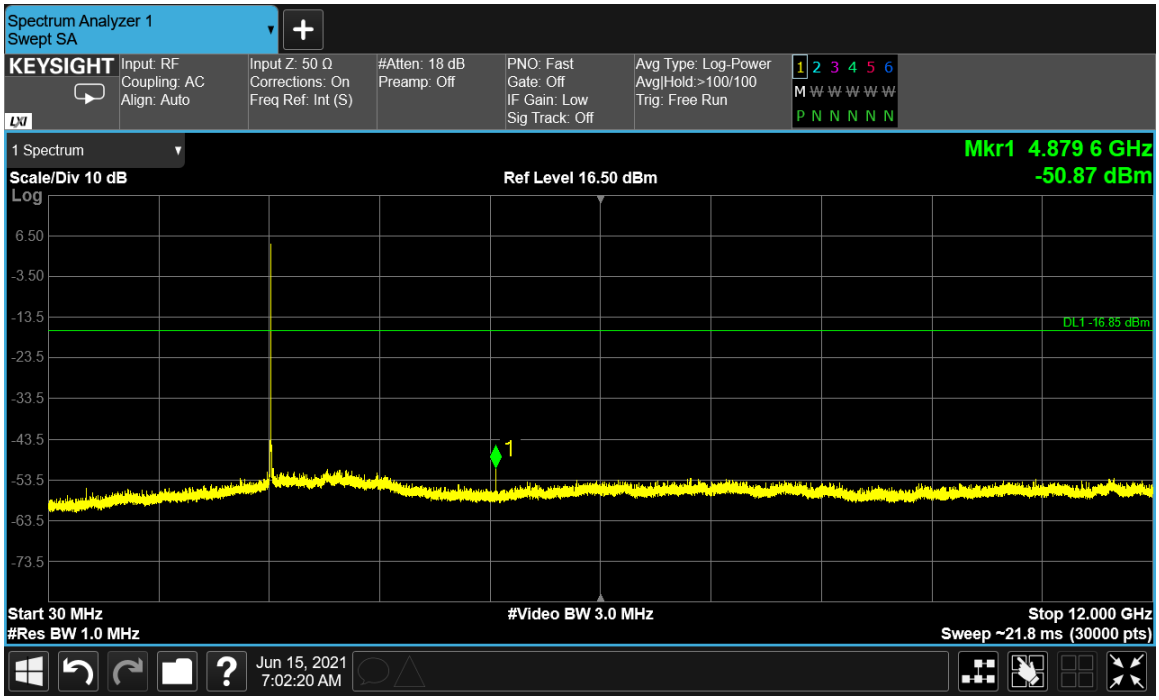

Figure 9-18 Conducted Spurious Emissions 30-12000 MHz (Ch. 19)

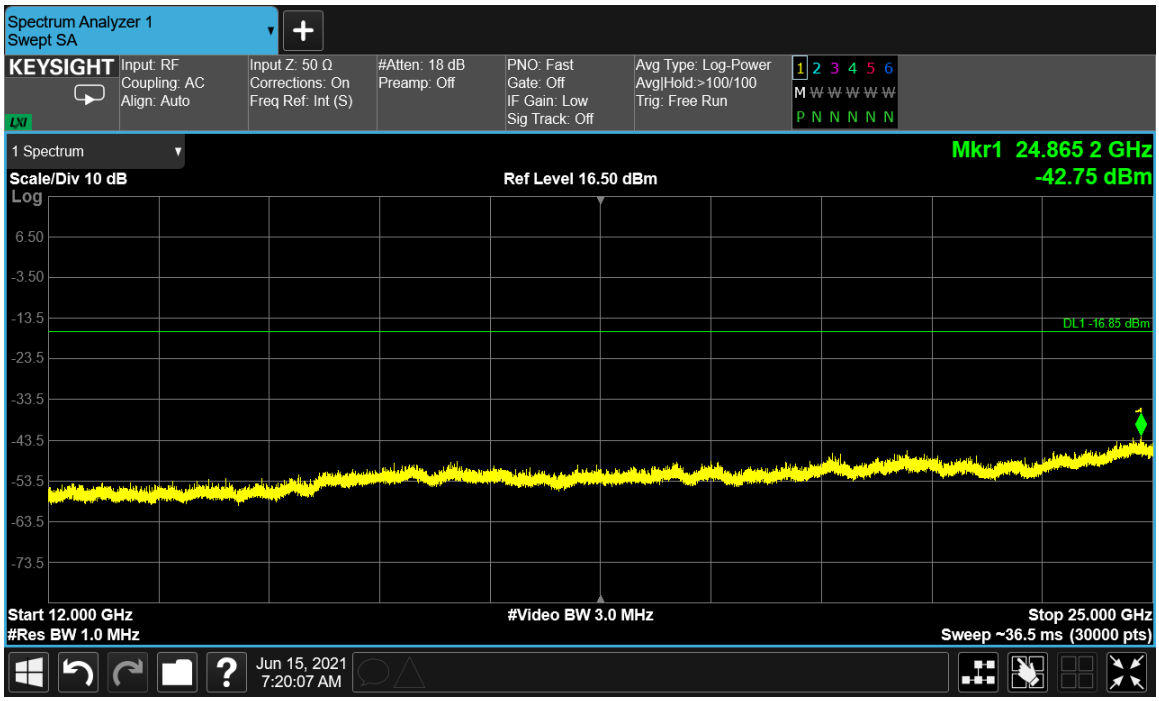

Figure 9-19 Conducted Spurious Emissions 12-25 GHz (Ch. 19)

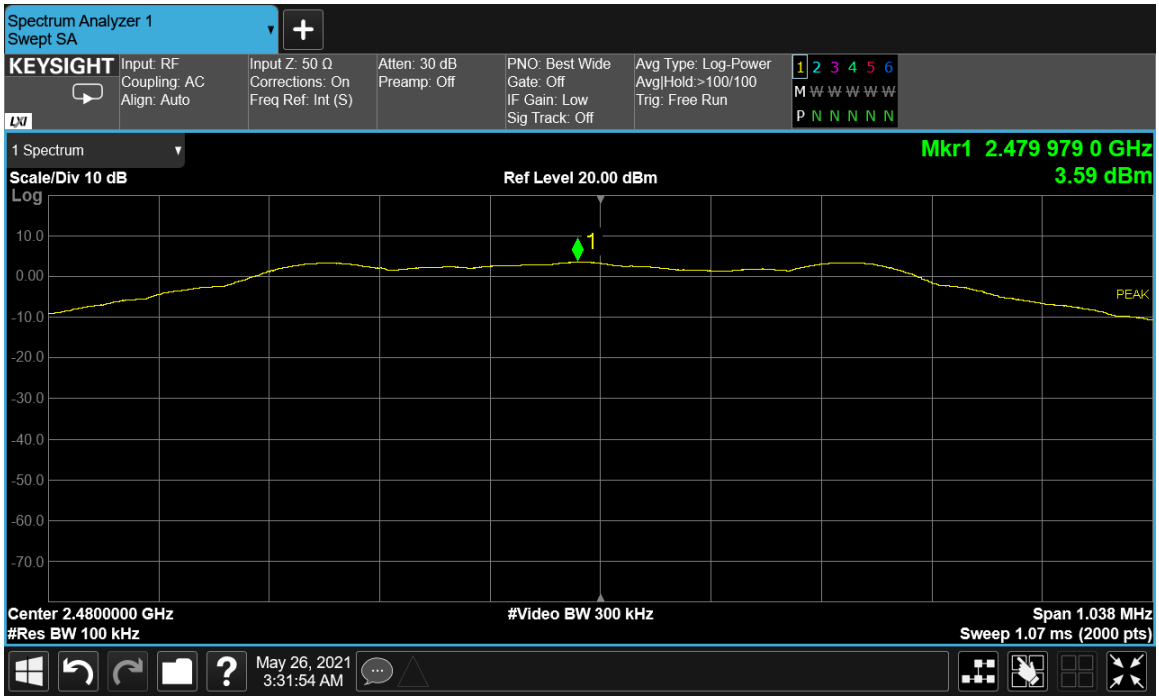

Figure 9-20 Reference Level Measurement (Ch.39)

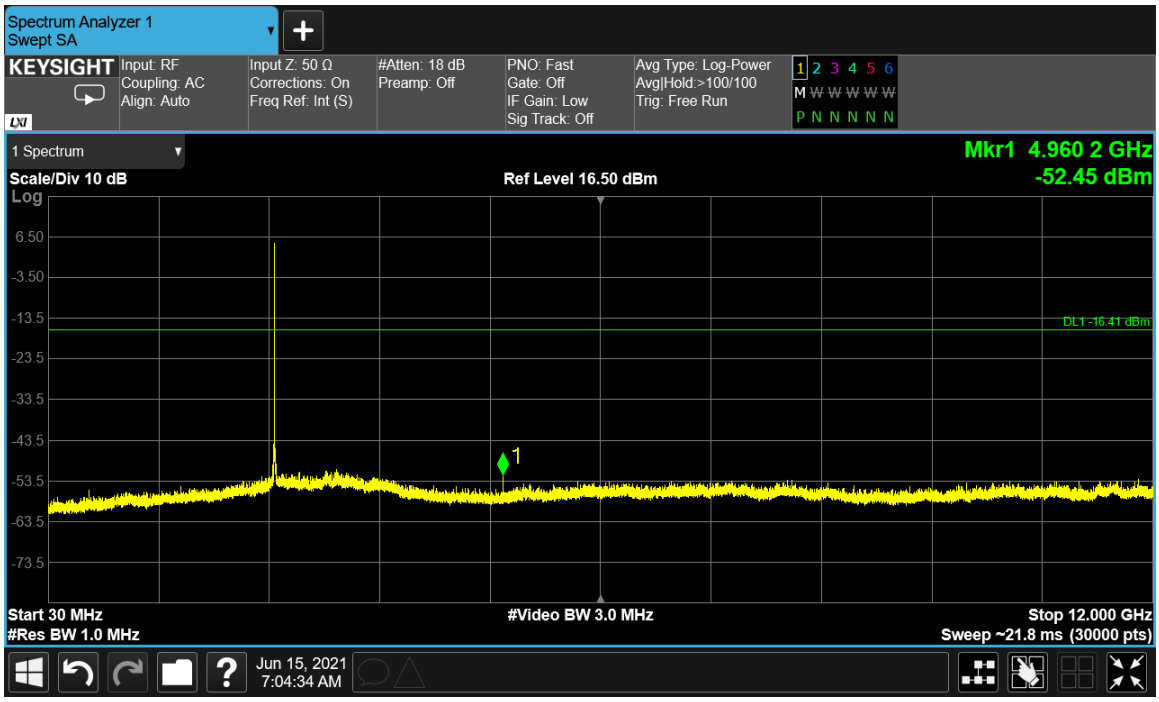

Figure 9-21 Conducted Spurious Emissions 30-12000 MHz (Ch.39)

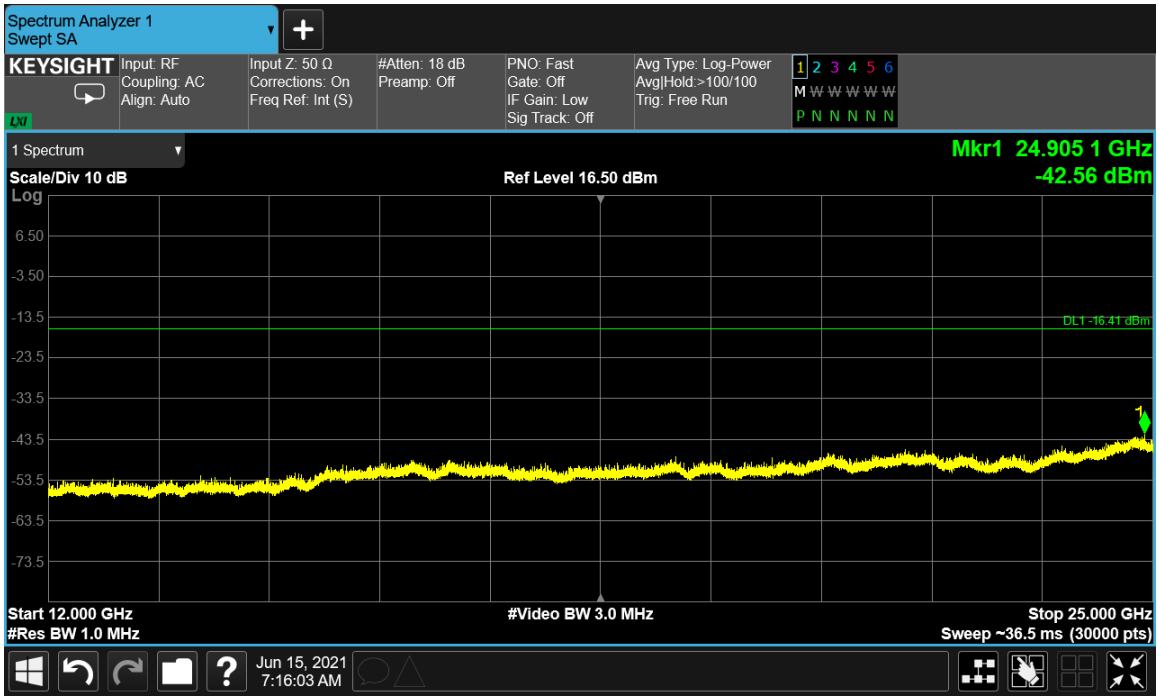

Figure 9-22 Conducted Spurious Emissions 12-25GHz (Ch.39)

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

Emission Level dBm = Raw Amplitude (dBm) + Cable and Attenuator Loss (dB)

i.e., $Emissions\ Level\ (dBm) = -20\ dBm + 14.2\ dB = -5.8\ dBm$

dBc level = Reference Level (dBm/100kHz) – Emission Level (dBm/100kHz)

i.e., $dBc = 17\ dBm - (-5.8)\ \text{dB} = 22.8\ dBc$

9.7.3 Limits:

All spurious emissions at least 20dBc.

9.7.4 Test Result:

Pass.

9.7.5 Test Data:

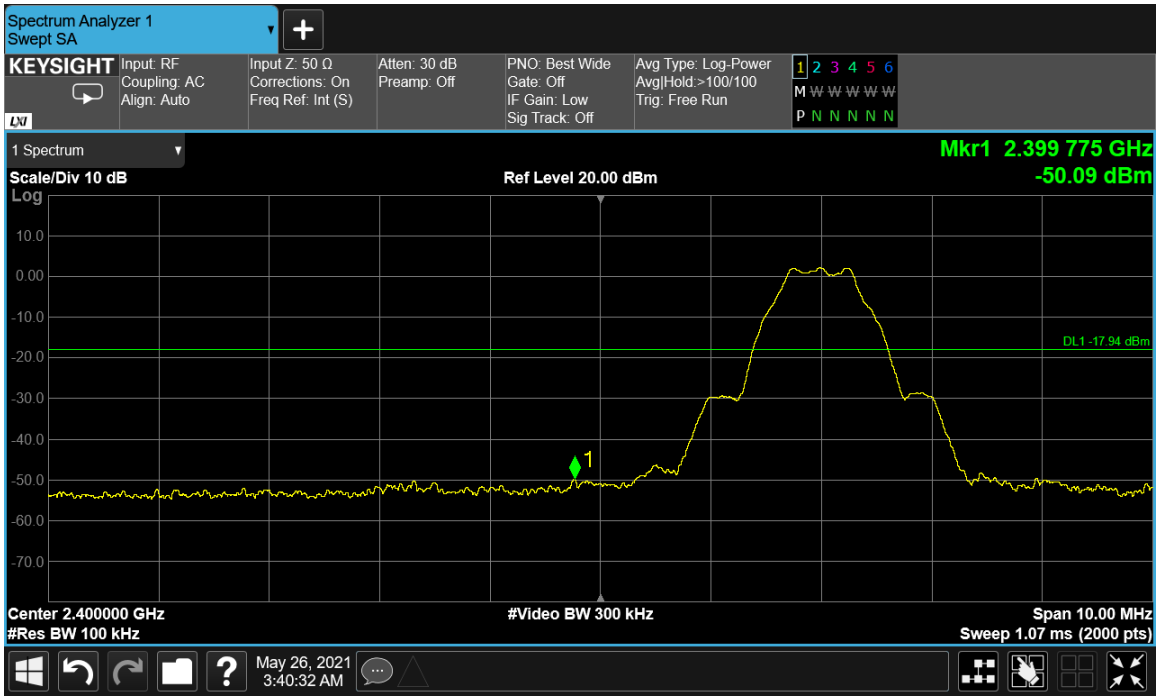

Figure 9-23 Conducted-Low Band Edge (Ch. 0)

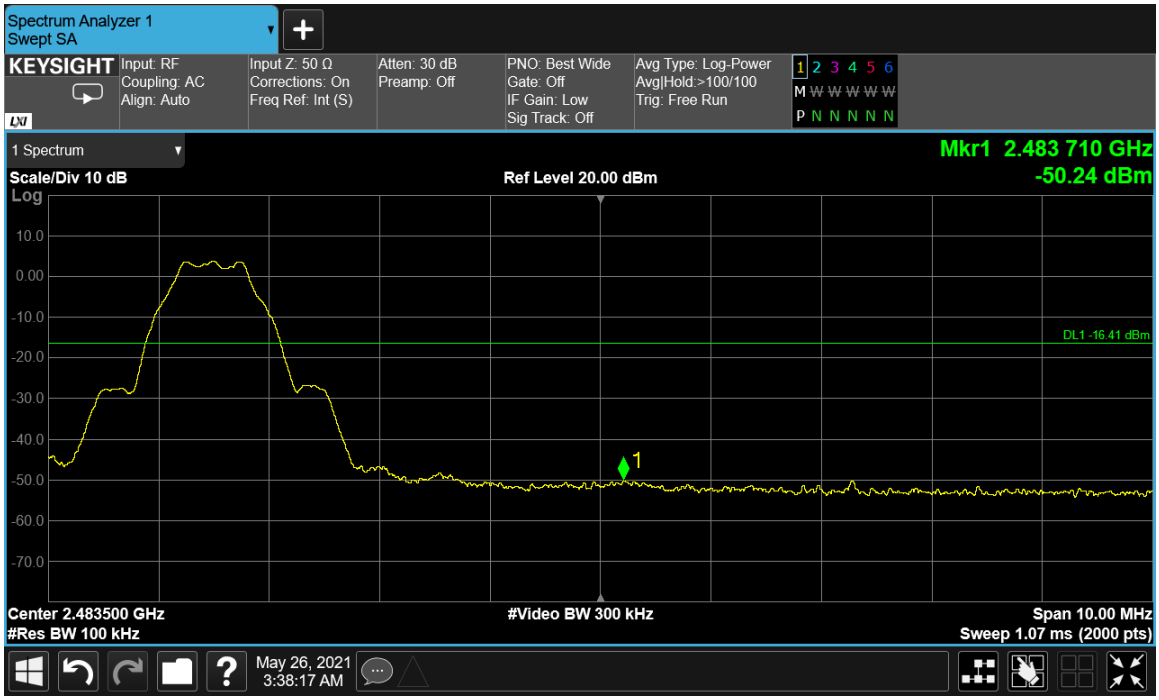

Figure 9-24 Conducted- High Band Edge (Ch. 39)

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 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. 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.

Radiated Spurious Emissions

Spectrum Analyzer Settings:

9 kHz- 30 MHz:

RBW= 1 kHz | 10kHz
VBW ≥ 3 X RBW
Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector and RBW's as defined in ANSI C63.2.
Span= 9 kHz – 150 kHz and 150 kHz- 30 MHz
Sweep time= Auto

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

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 Calculation:

Field Strength Level: Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) – Amplifier Gain = 50dBuV + 33 dB/m – 25 dB = 58dBuV/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)
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X kHz resulted in a level of Y dBµV/m, which is equivalent to Y-51.5 = Z dBµA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to be 15.209(a) limit.			

9.8.4 Test Result:

Pass.

9.8.5 Test Data:

9.8.5.1 Radiated Restricted Band-edge emissions

RSE 1 - 18GHz Average Data							
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Avg. Amplitude (dBµV)**	**Correction Factor (dB/m)**	**DC Correction Factor (dB)**	**Corrected Avg. Field Strength (dBµV/m)**	**Average Limit (dBµV/m)**	**Margin (dB)**
2402	2387.56	26.29	14.4	0	40.69	54	-13.31
2480	2483.80	27.26	15.0	0	42.26	54	-11.74

RSE 1 - 18GHz Peak Data						
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Peak Amplitude (dBµV)**	**Correction Factor (dB/m)**	**Corrected Peak Field Strength (dBµV/m)**	**Peak Limit (dBµV/m)**	**Margin (dB)**
2402	2351.04	38.98	14.3	53.28	74	-20.72
2480	2484.80	39.23	15.0	54.23	74	-19.77

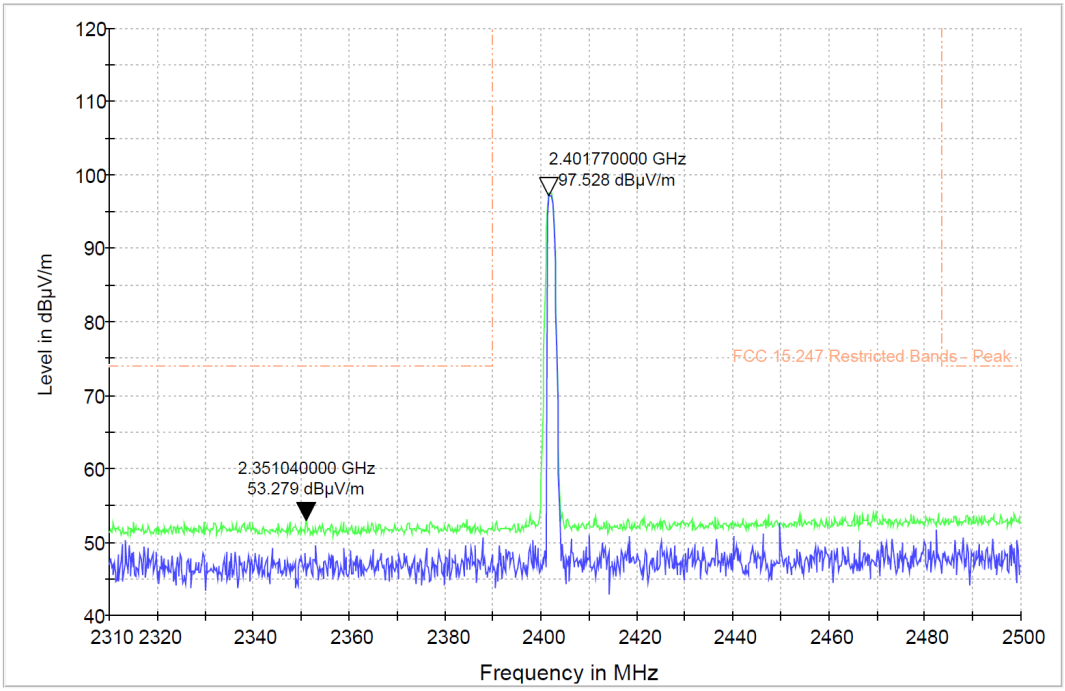

Figure 9-25 Radiated Restricted Band Edge (Ch. 0) Peak

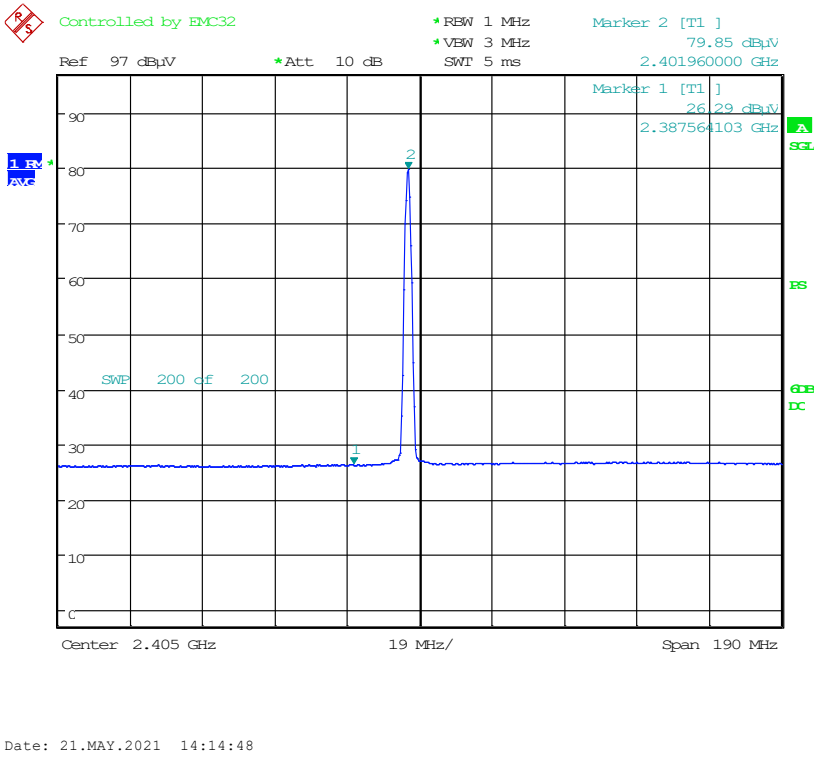

Figure 9-26 Radiated Restricted Band Edge (Ch. 0) Average

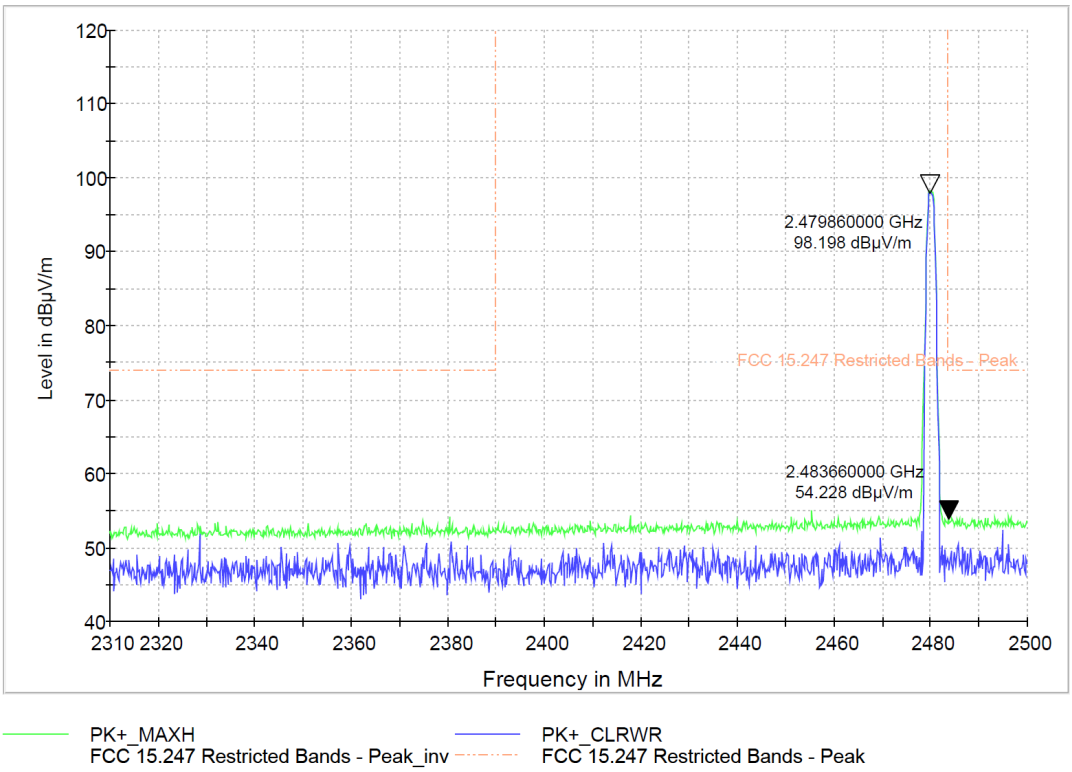

Figure 9-27 Radiated Restricted Band Edge (Ch. 39) Peak

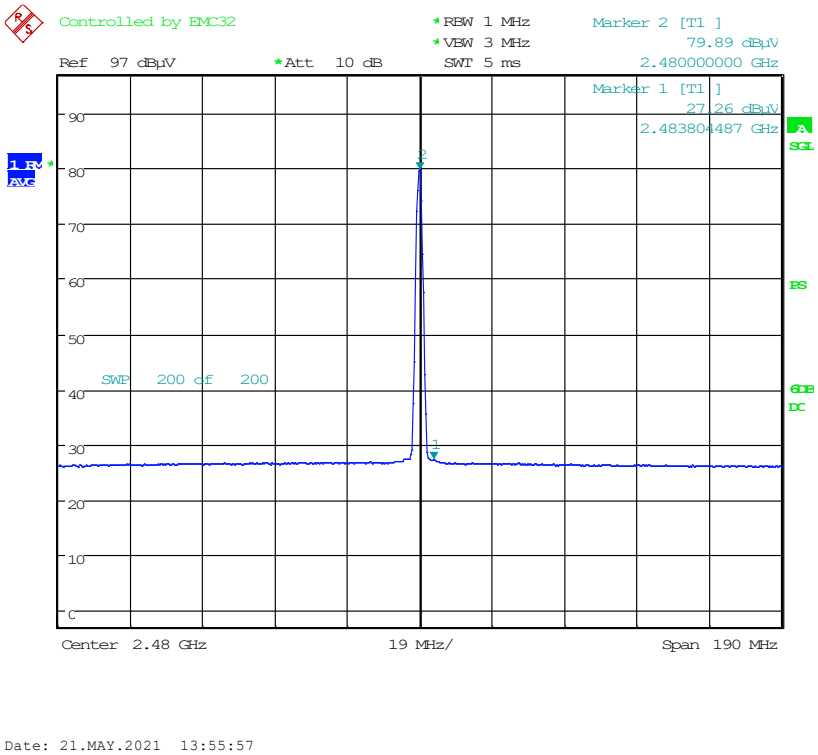

Figure 9-28 Radiated Restricted Band Edge (Ch. 39) Average

9.8.5.2 Emissions in 9kHz-1GHz range

All channels and polarizations were tested and worst-case results from channel 19 with Parallel orientation shown here.

RSE 9kHz -30 MHz						
Carrier Frequency (MHz)	**Emission Frequency (MHz)**	**Raw Quasi-Peak Amplitude (dBµV/m)**	**Correction Factor (dB/m)**	**Corrected Quasi-Peak Field Strength (dBµV/m)**	**Quasi-Peak Limit (dBµV/m)**	**Quasi-Peak Margin (dB)**
2440	0.019	-11.15	0.3	-10.85	42.03	-52.88
2440	0.174	-3.89	-18.8	-22.69	22.79	-45.48
2440	0.495	-6.72	12.1	5.38	33.71	-28.33
2440	7.076	-11.53	-4.7	-16.23	29.54	-45.77
2440	11.905	-7.25	-5.2	-12.45	29.54	-41.99
2440	24.078	-7.25	-5.4	-12.65	29.54	-42.19

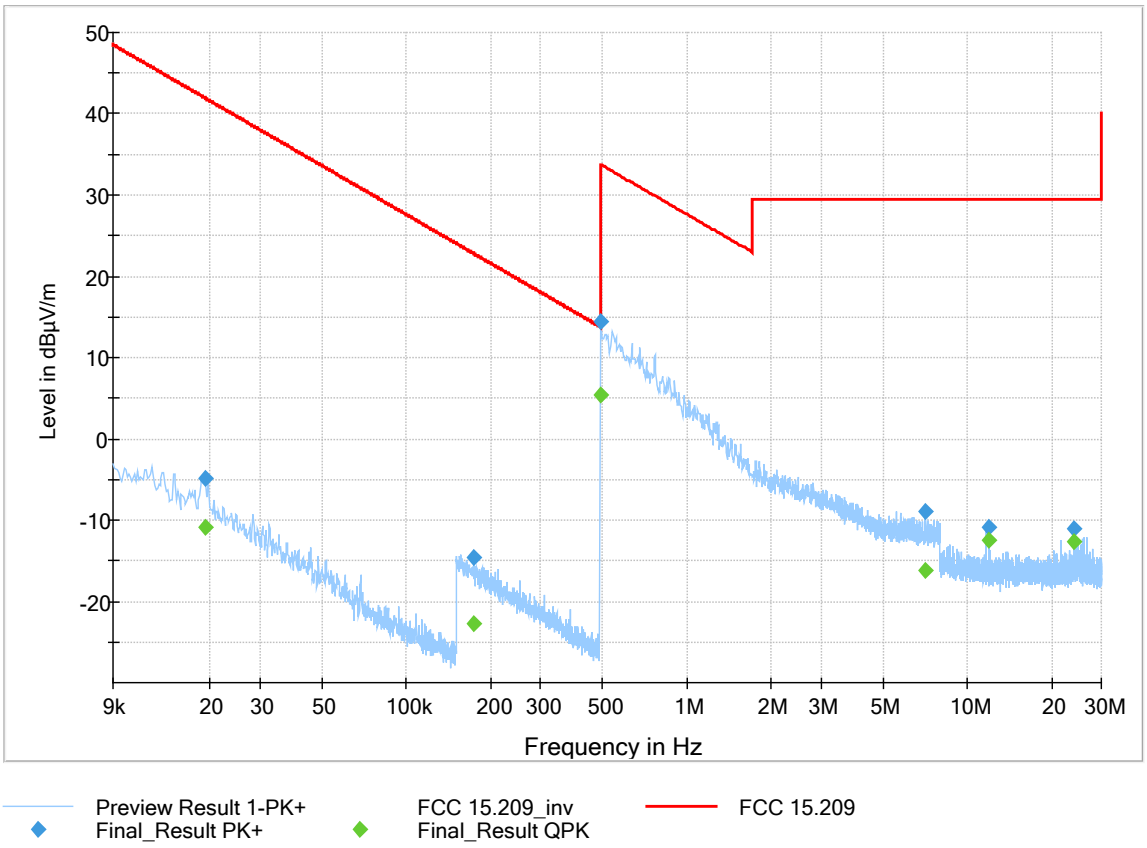

Figure 9-29 Radiated Spurious Emissions (Ch.19) 2440 (9kHz – 30MHz)

9.8.5.3 Emissions in 30 MHz- 1 GHz range

All channels were tested and worst-case results from channel 19 shown here.

RSE 30-1000 MHz						
Carrier Frequency (MHz)	**Emission Frequency (MHz)**	**Raw Quasi-Peak Amplitude (dBµV/m)**	**Correction Factor (dB/m)**	**Corrected Quasi-Peak Field Strength (dBµV/m)**	**Quasi-Peak Limit (dBµV/m)**	**Quasi-Peak Margin (dB)**
2440	950.67	-0.84	31.8	30.96	46	-15.04

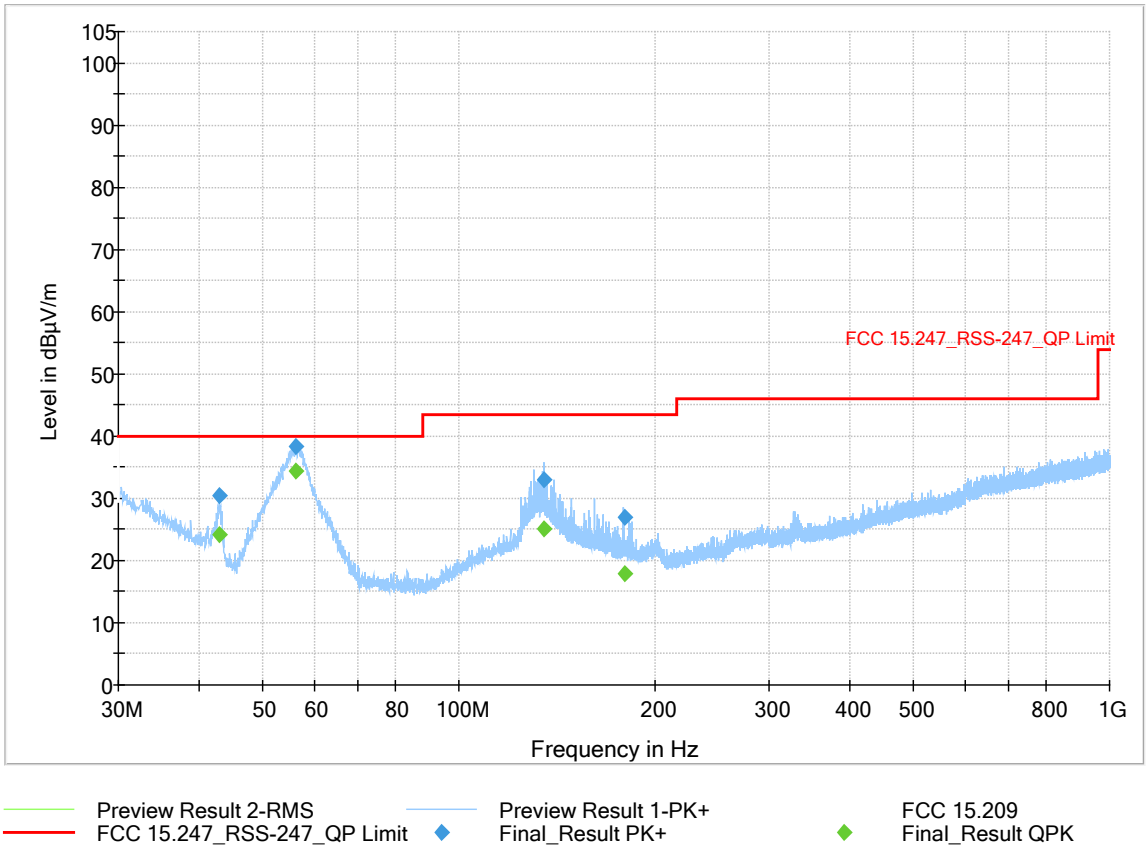

Figure 9-30 Radiated Spurious Emissions – Ambient Emissions, Radio OFF

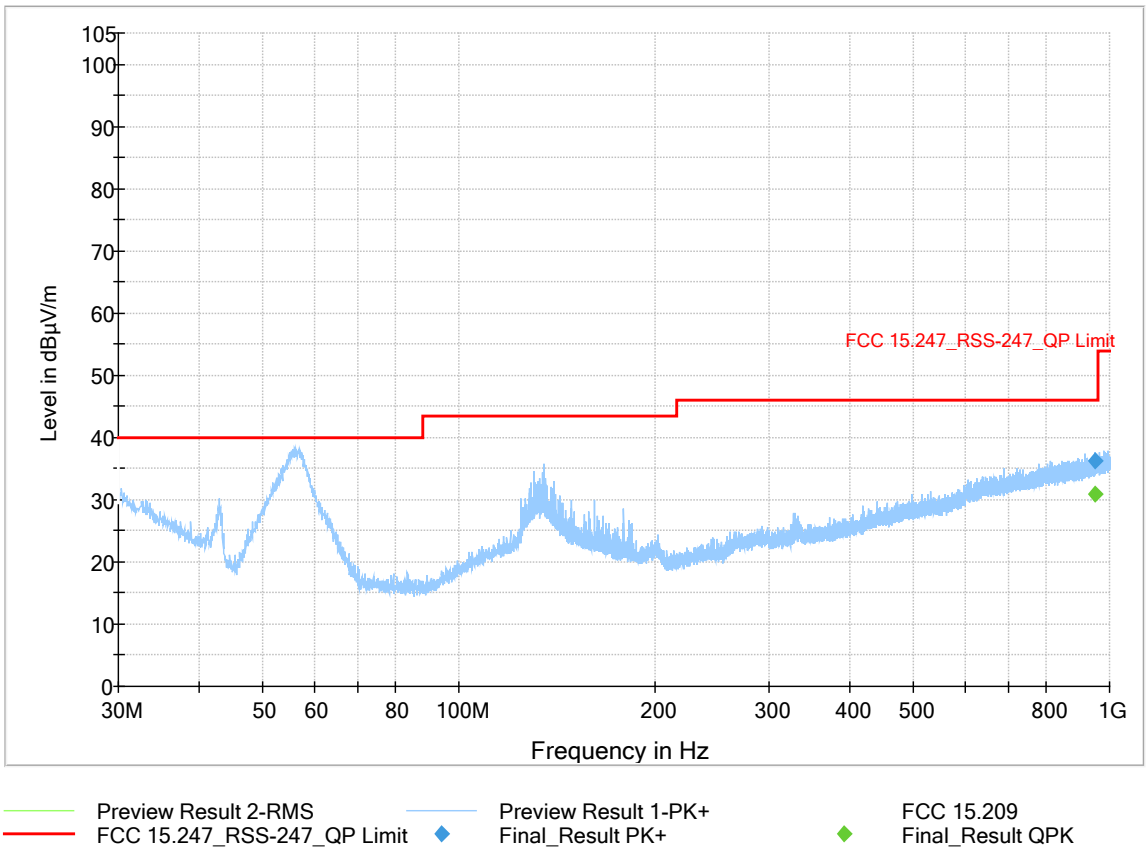

Figure 9-31 Radiated Spurious Emissions (Ch.19) 2440 (30MHz – 1GHz)

9.8.5.4 Emissions in 1-18 GHz range

RSE 1 - 18GHz Average Data							
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Avg. Amplitude (dBµV)**	**Correction Factor (dB/m)**	**DC Correction Factor (dB)**	**Corrected Avg. Field Strength (dBµV/m)**	**Average Limit (dBµV/m)**	**Margin (dB)**
2402	3256*	31.83	7.7	0	39.53	54	-14.47
2402	4804	32.65	9.4	2.32	44.37	54	-9.63
2440	3256*	33.04	7.7	0	40.74	54	-13.26
2440	4880	35.60	9.2	2.30	47.10	54	-6.90
2480	3256*	33.60	7.7	0	41.30	54	-12.70
2480	4960	35.33	9.1	2.24	40.67	54	-7.33

Note 1: Frequencies marked with (*) do not fall in the restricted band

RSE 1 - 18GHz Peak Data						
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Peak Amplitude (dBµV)**	**Correction Factor (dB/m)**	**Corrected Peak Field Strength (dBµV/m)**	**Peak Limit (dBµV/m)**	**Margin (dB)**
2402	3256*	37.94	7.7	45.64	74	-28.36
2402	4804	40.81	9.4	50.21	74	-23.79
2440	3256*	39.24	7.7	46.94	74	-27.06
2440	4880	43.16	9.2	52.36	74	-21.64
2480	3256*	39.10	7.7	46.80	74	-27.20
2480	4960	43.23	9.1	52.33	74	-21.67

Note 1: Frequencies marked with (*) do not fall in the restricted band

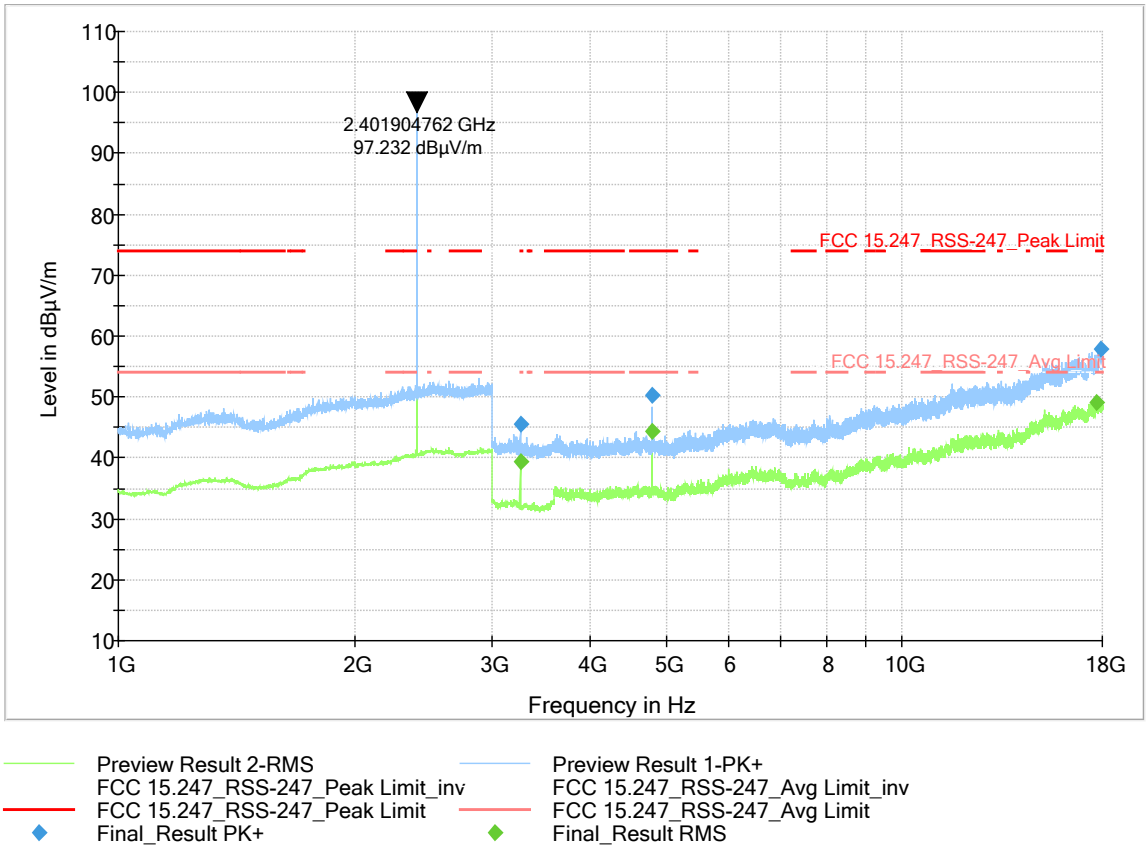

Figure 9-32 Radiated Spurious Emissions 1-18 GHz (Ch. 0)

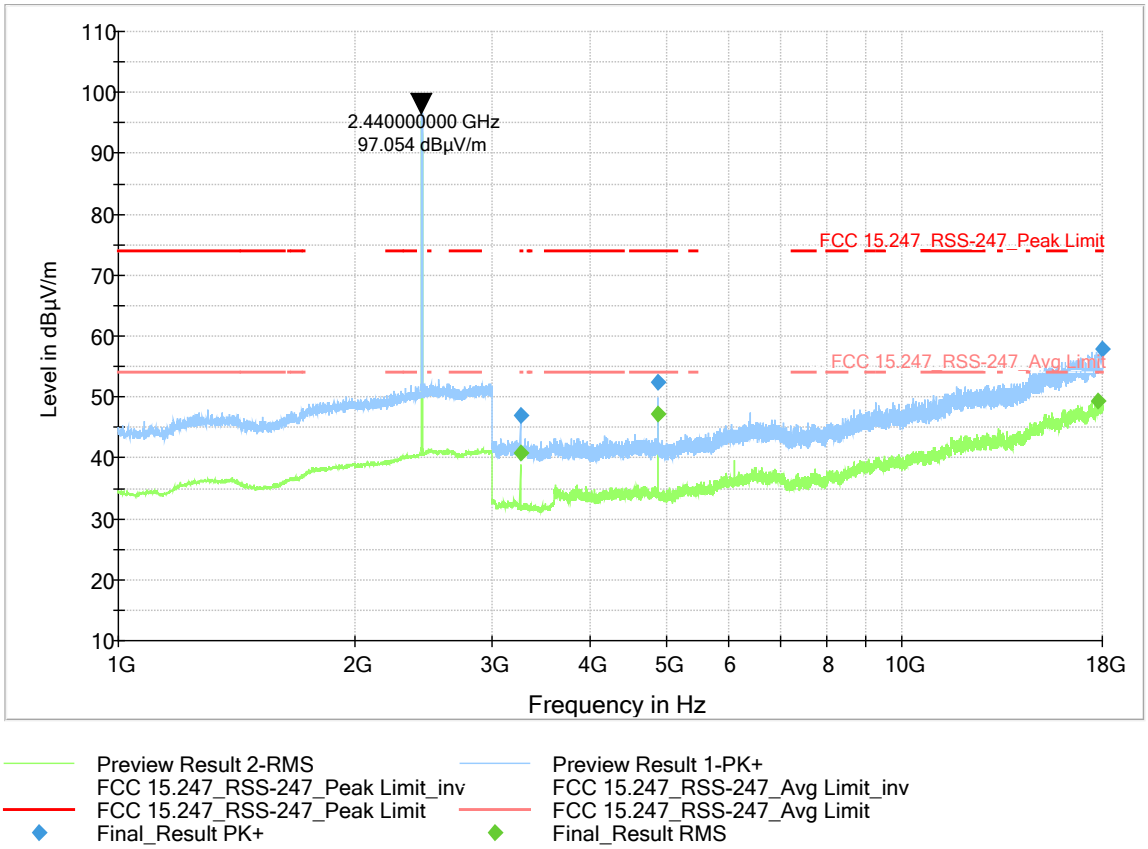

Figure 9-33 Radiated Spurious Emissions 1-18 GHz (Ch. 19)

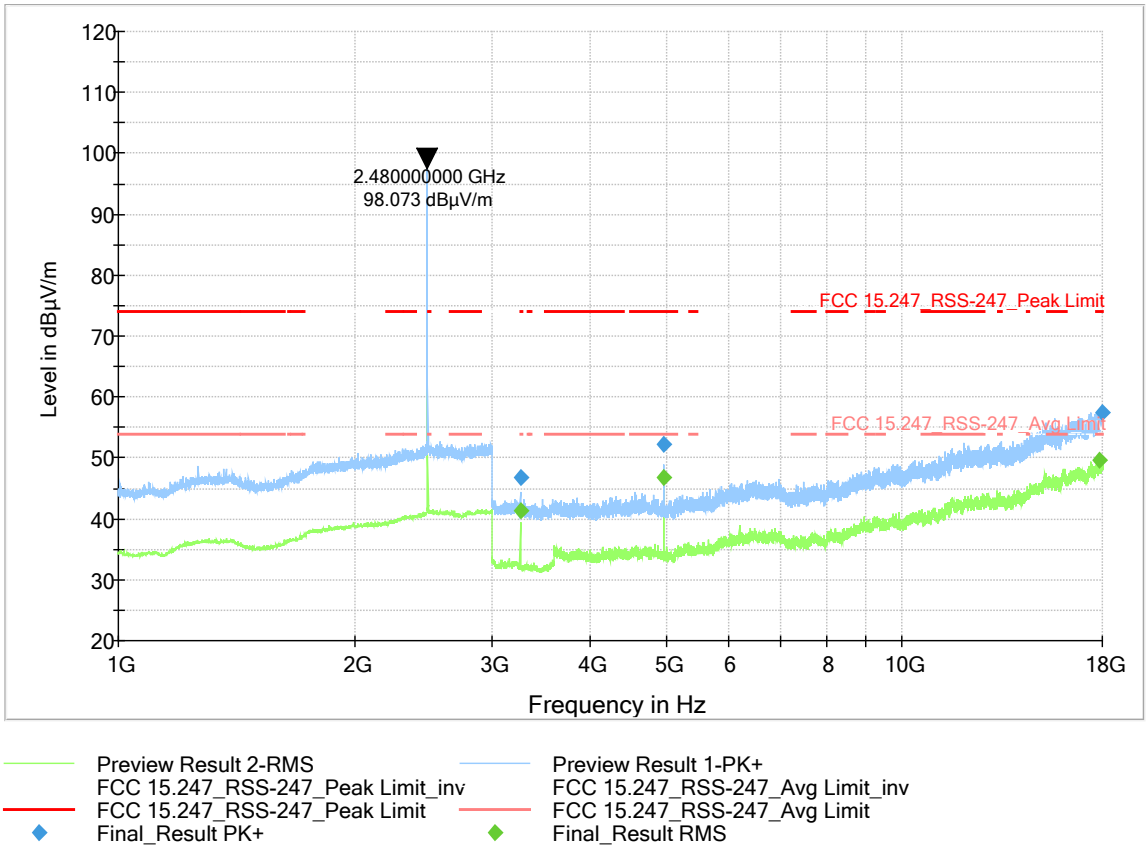

Figure 9-34 Radiated Spurious Emissions 1-18 GHz (Ch. 39)

9.8.5.5 Emissions in 18-26.5 GHz range

All channels were tested and worst-case results from channel 19 (2440 MHz) shown here.
No significant emissions to report above noise floor.

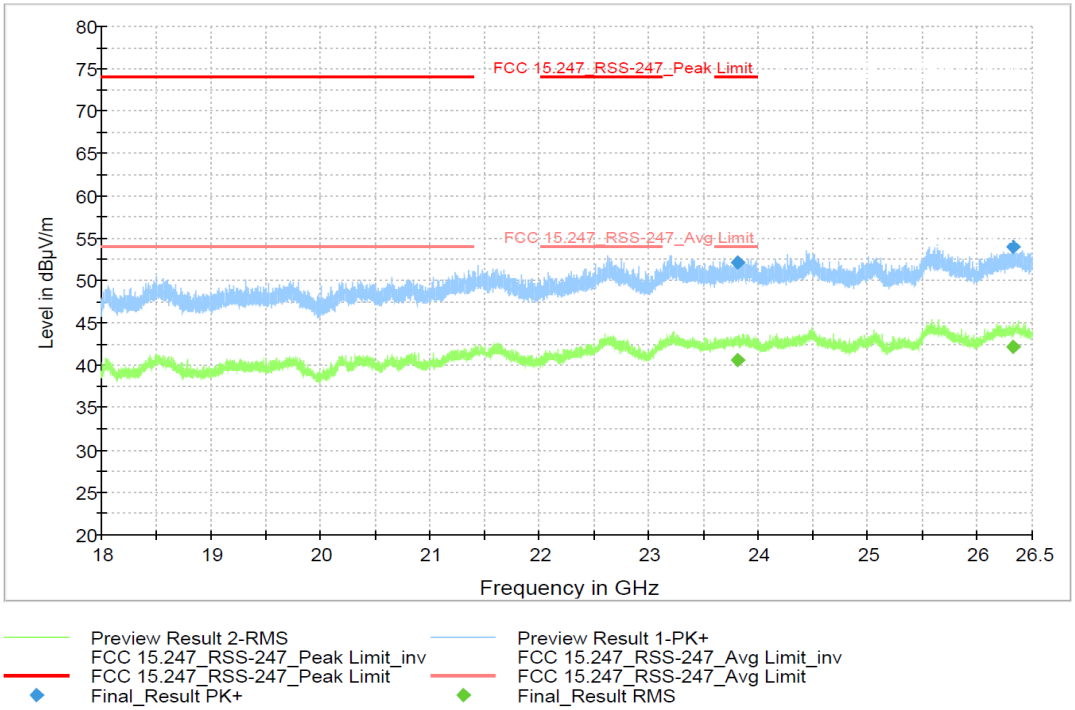

Figure 9-35 Radiated Spurious Emissions (Ch. 19) (18 – 26.5 GHz)

RSE 18 – 26.5GHz Average Data							
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Avg. Amplitude (dBµV)**	**Correction Factor (dB/m)**	**DC Correction Factor (dB)**	**Corrected Avg. Field Strength (dBµV/m)**	**Average Limit (dBµV/m)**	**Margin (dB)**
2440	23805.92	26.74	13.9	0	40.64	54	-13.36
2440	26324.90	28.33	13.9	0	42.23	54	-11.77

RSE 18 – 26.5GHz Peak Data						
Carrier Frequency (MHz)	**Frequency (MHz)**	**Raw Peak Amplitude (dBµV)**	**Correction Factor (dB/m)**	**Corrected Peak Field Strength (dBµV/m)**	**Peak Limit (dBµV/m)**	**Margin (dB)**
2440	23805.90	38.30	13.8	52.10	74	-21.90
2440	26332.55	40.06	13.9	53.96	74	-20.04

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.19 at 4dBm power setting.

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

Sample Calculation
Emission Level dBµV = Raw Amplitude (dBµV) + Cable and Attenuator Loss (dB) + LISN Correction Factor (dB)

i.e., $Emission\ Level\ (dB\mu V) = 25\ dB\mu V + 6.3\ dB + 9.8\ dB = 41.1\ dB\mu V$

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:

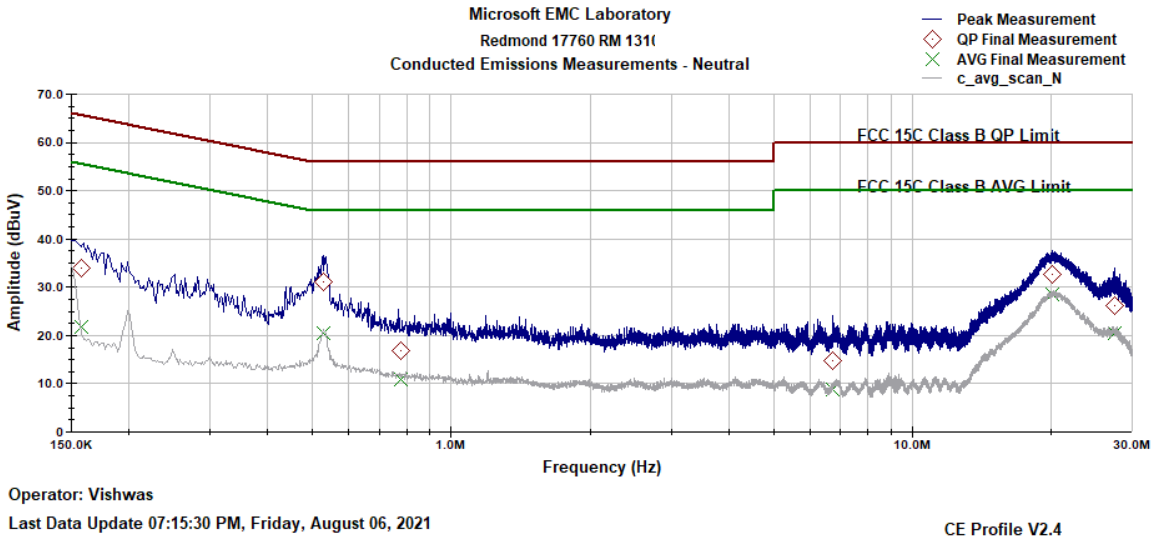

Figure 9-36 AC Line Conducted Emissions- Neutral (150 kHz- 30 MHz)

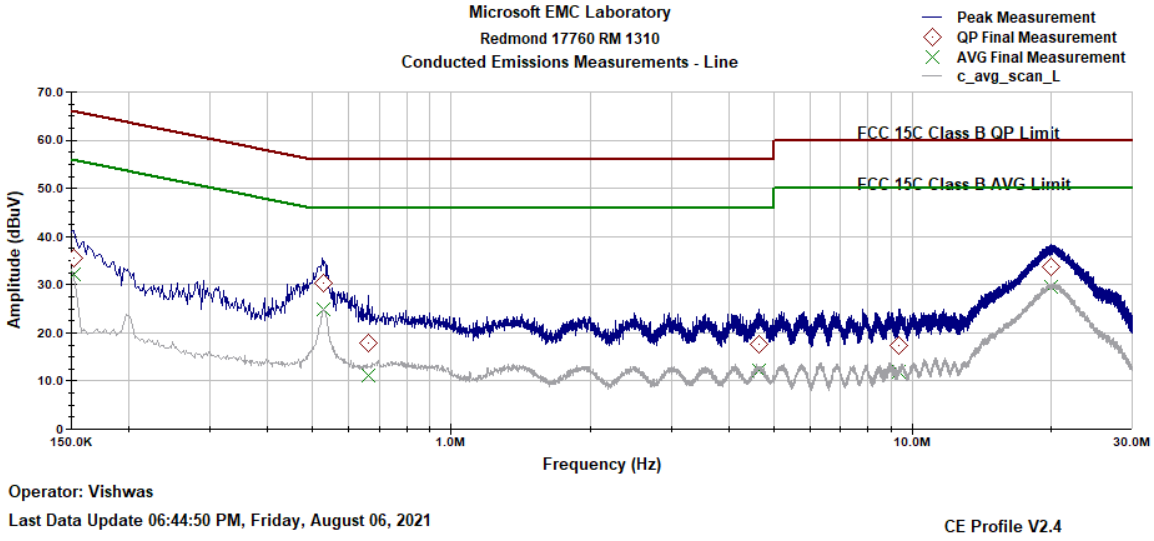

Figure 9-37 AC Line Conducted Emissions- Line (150 kHz- 30 MHz)

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)
0.152	35.57	32.02	65.87	55.87	L	-30.30	-23.85
0.529	30.24	24.80	56.00	46.00	L	-35.76	-21.20
0.663	17.81	11.11	56.00	46.00	L	-38.19	-34.89
4.648	17.60	12.06	56.00	46.00	L	-38.40	-33.94
9.360	17.45	11.89	60.00	50.00	L	-42.55	-38.11
20.072	33.61	29.64	60.00	50.00	L	-26.39	-20.36
0.157	34.07	21.64	65.60	55.60	N	-31.53	-33.96
0.527	31.02	20.60	56.00	46.00	N	-24.98	-25.40
0.778	16.92	10.96	56.00	46.00	N	-39.08	-35.04
7.715	14.74	8.69	60.00	50.00	N	-45.27	-41.31
20.117	32.62	28.56	60.00	50.00	N	-27.38	-21.44
27.464	26.19	20.49	60.00	50.00	N	-33.82	-29.51

End of Report