HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

September 26, 2019

Autani, LLC.
7090 Columbia Gateway Drive, Suite 140
Columbia, MD 21046

Dear Scott Metker,

Enclosed is the EMC Wireless test report for compliance testing of the Autani, LLC., PSC autaniNet Module as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of Eurofins MET Labs, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS MET LABS, INC.

Michelle Tawmging
Documentation Department

Reference: (\Autani, LLC.\EMC104922-FCC247)

Electromagnetic Compatibility Criteria
Test Report

for the

Autani, LLC.
PSC autaniNet Module

Tested under
the FCC Certification Rules
contained in
15.247 Subpart C for Intentional Radiators

MET Report: EMC104922-FCC247

September 26, 2019

Prepared For:

Autani, LLC.
7090 Columbia Gateway Drive, Suite 140
Columbia, MD 21046

Prepared By:
Eurofins MET Labs, Inc.
914 W. Patapsco Avenue
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
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Deepak Giri, Project Engineer
Electromagnetic Compatibility Lab

Michelle Tawmging
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.247 under normal use and maintenance.

Christopher Dennison,
Manager, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	September 26, 2019	Initial Issue

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List of Figures

List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**er**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**er**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**micro**henry
µ	**micro**farad
µs	**micro**seconds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

A.

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Autani, LLC. PSC autaniNet Module, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the PSC autaniNet Module. Autani, LLC. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the PSC autaniNet Module, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Autani, LLC., purchase order number 10626. All tests were conducted using measurement procedure ANSI C63.10-2013.

FCC Reference 47 CFR Part 15.247	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(2)	6dB Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(c)	Spurious Emissions in Non-restricted Bands	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	Peak Power Spectral Density	Compliant
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliant

Figure 1: Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A.
A. Overview

Eurofins MET Labs, Inc. was contracted by Autani, LLC. to perform testing on the PSC autaniNet Module, under Autani, LLC.'s purchase order number 10626.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Autani, LLC., PSC autaniNet Module.

The results obtained relate only to the item(s) tested.

Model Tested:	PSC autaniNet Module	
Model Covered:	PSC autaniNet Module	
EUT Specifications:	Primary Power: 3.3VDC	
	FCC ID: V8NPSC1000179	
	Type of Modulations:	O-QPSK
	Equipment Code:	DTS
	Peak RF Output Power:	10.61 dBm
	EUT Frequency Ranges:	2.405-2.475GHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Deepak Giri	
Report Date:	September 26, 2019	

Figure 2: EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
KDB 558074 D01 v05r02	Guidance For Performing Compliance Measurements On Digital Transmission Systems (DTS) Operating Under Section 15.247

Figure 3: References

C. Test Site

All testing was performed at Eurofins MET Labs, Inc., 914 W. Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology. FCC designation number is US1052.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

Figure 4: Uncertainty Calculations Summary

E. Description of Test Sample

The Autani, LLC. PSC autaniNet Module, Equipment Under Test (EUT), controls the operation of a 3rd party wall switch and motion sensor. Specifically, our wireless module controls the basic functions of the 3rd party wall switch and motion sensor.

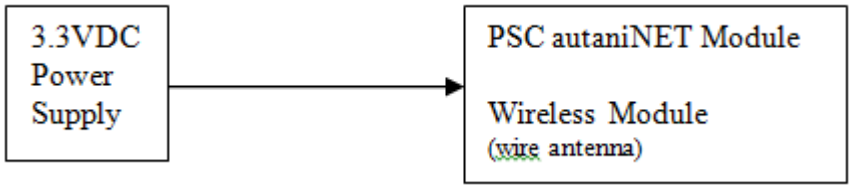

Figure 5: Block Diagram of Test Configuration

F. Equipment Configuration

The EUT was set up as outlined in Figure 5, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
1	N/A	PSC autaniNET Module	1000179-01	1000179-01	varies	1
2	N/A	3.3VDC Power Supply	varies	varies	varies	N/A

Figure 6: Equipment Configuration

G. Support Equipment

The EUT did not require any support equipment for operation or monitoring.

H. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	Unit Interface	6-pin Header	1	0	0	N	1

Figure 7: Ports and Cabling Information

I. Mode of Operation

Production Mode:

The PSC autaniNET Module is configured wirelessly through the ZigBee interface. Once configured the mode of operation is dependent on the firmware loaded into the device; however, each mode has the same basic features. Each mode allows wireless traffic to be transferred over the connected interface.

FCC Mode:

The PSC autaniNET Module contains a special image to facilitate FCC testing. This image represents the worse possible case from a noise perspective. The following details the operation and how to change states.

There is one switch (SW1) and one bi-color LED (LED1) on the PSC autaniNET Module. The function is as follows:

1) At board power-on, LED is off and there is no RF transmission.

2) A long press, ~ 3 seconds, of SW1 repeatedly sequences through the RF channels.
3) A short press, ~1 second, of SW1 while states in 1-4 above causes the CW tone to be replaced with a modulated tone containing pseudo-random data. LED1 turns solid green while the pseudo-random modulation is in effect.

J. Method of Monitoring EUT Operation

Production Mode:

The device has two LEDs which provide status feedback to the user/installer. If the device is operating as anticipated one of the LEDs will be blinking red or green. If the device is not performing to the manufacturer's intended operation the LEDs should be off.

FCC Test Mode:

K. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Autani, LLC. upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Test Results: The EUT as tested is **compliant** the criteria of §15.203. EUT has IPEX MHf antenna connector and has gain of 1.5 dBi

Test Engineer: Deepak Giri

Test Date: August 24, 2019

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15- 0.5	66 - 56	56 - 46
0.5 - 5	56	46
5 - 30	60	50

Figure 8: Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.10-2013 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

Test Results: The EUT was **compliant** with this requirement. Measured emissions were below applicable limits.

Note: Corrected Measurement = Uncorrected data+Cable loss+ACF

Test Engineer: Deepak Giri

Test Date: August 22, 2019

Test Data

Frequency (MHz)	Uncorrected Meter Reading (dBµV) QP	Cable Loss (dB)	Corrected Measurement (dBµV) QP	Limit (dBµV) QP	Pass/ Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBµV) Avg.	Cable Loss (dB)	Corrected Measurement (dBµV) AVG	Limit (dBµV) AVG	Pass/ Fail QP	Margin (dB) AVG
0.1622	8.961	0	18.961	65.35	PASS	-46.389	3.011	0	13.011	55.35	PASS	-42.339
0.34	11.87	0	21.87	59.2	PASS	-37.33	3.669	0	13.669	49.2	PASS	-35.531
0.676	7.532	0	17.532	56	PASS	-38.468	2.515	0	12.515	46	PASS	-33.485
0.946	7.178	0	17.178	56	PASS	-38.822	1.038	0	11.038	46	PASS	-34.962
5.5	7.023	0	17.023	60	PASS	-42.977	2.231	0	12.231	50	PASS	-37.769
11.55	8.06	0	18.06	60	PASS	-41.94	2.611	0	12.611	50	PASS	-37.389

Figure 9: Conducted Emissions Limits, Phase Line, Test Results

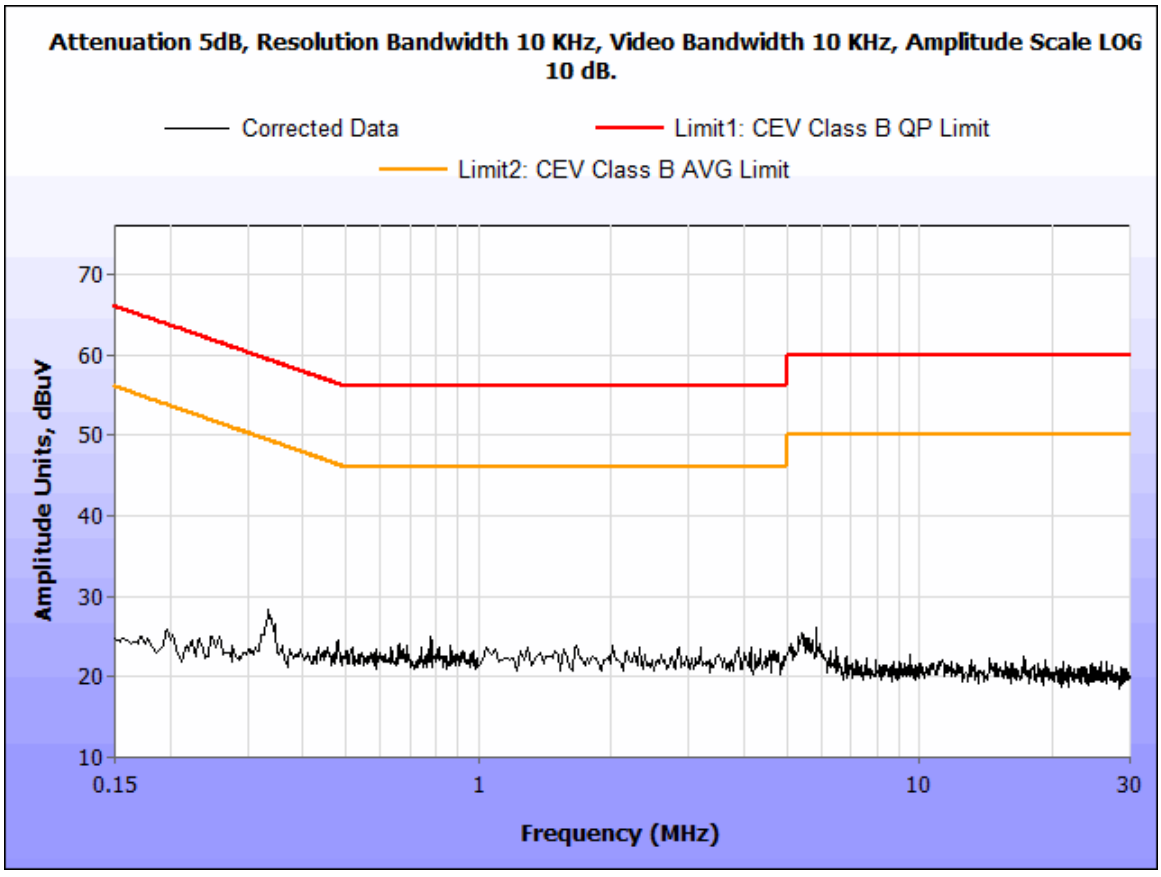

Figure 10: Conducted Emissions Limits, Phase Line, Prescan

Frequency (MHz)	Uncorrected Meter Reading (dBµV) QP	Cable Loss (dB)	Corrected Measurement (dBµV) QP	Limit (dBµV) QP	Pass/ Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBµV) Avg.	Cable Loss (dB)	Corrected Measurement (dBµV) AVG	Limit (dBµV) AVG	Pass/ Fail QP	Margin (dB) AVG
0.1556	9.258	0	19.258	65.7	PASS	-46.442	3.325	0	13.325	55.7	PASS	-42.375
0.341	11.96	0	21.96	59.18	PASS	-37.22	4.015	0	14.015	49.18	PASS	-35.165
0.742	9.08	0	19.08	56	PASS	-36.92	2.071	0	12.071	46	PASS	-33.929
4.713	9.851	0	19.851	56	PASS	-36.149	2.188	0	12.188	46	PASS	-33.812
14.7	6.86	0	16.86	60	PASS	-43.14	2.285	0	12.285	50	PASS	-37.715
25.68	4.355	0	14.355	60	PASS	-45.645	2.336	0	12.336	50	PASS	-37.664

Figure 11: Conducted Emissions Limits, Neutral Line, Test Results

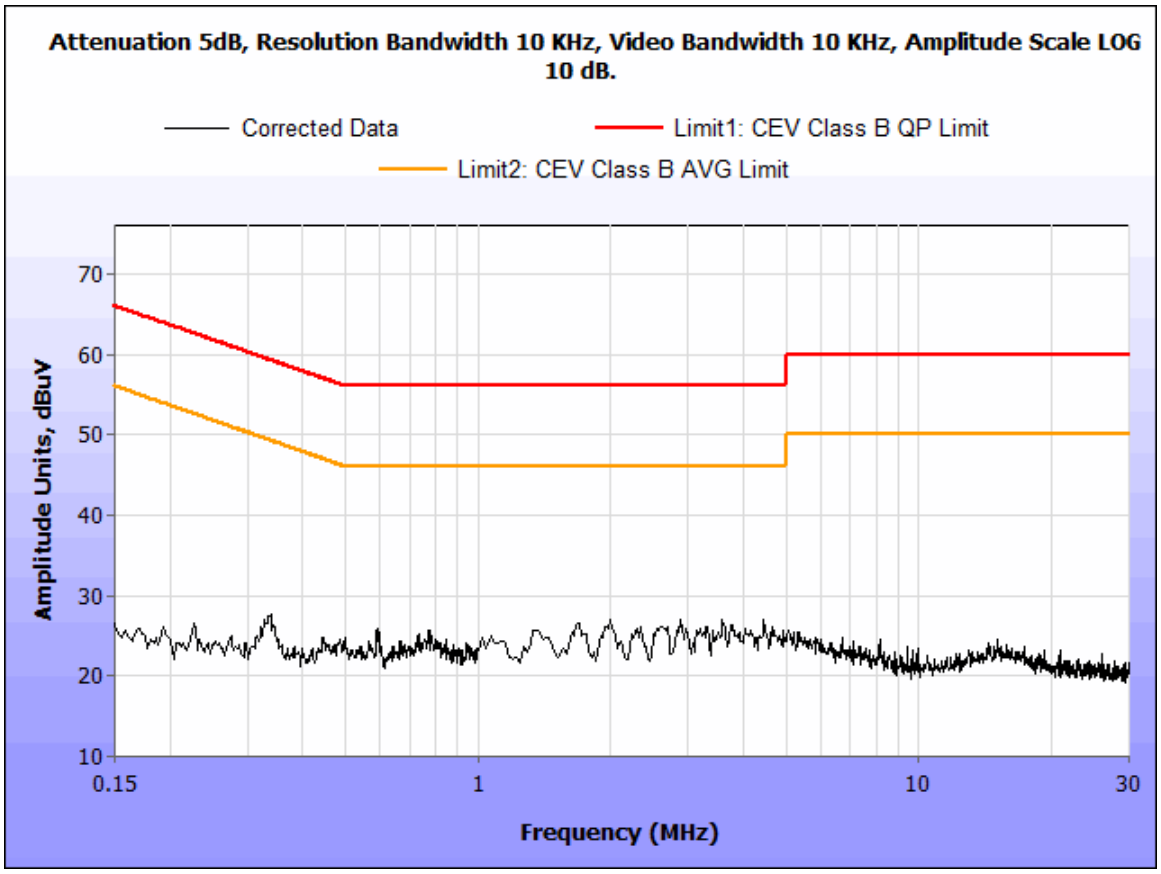

Figure 12: Conducted Emissions Limits, Neutral Line, Prescan

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(a)(2) 6 dB Bandwidth

Test Requirements: **§ 15.247(a)(2):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Procedure: The transmitter was on and transmitting at the highest output power. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW = 100kHz, VBW = 3*RBW. The 6 dB Bandwidth was measured and recorded. The measurements were performed on the low, mid and high channels.

Test Results The EUT was **compliant** with § 15.247 (a)(2).

The 6 dB Bandwidth was determined from the plots on the following pages.

Test Engineer: Deepak Giri

Test Dates: August 21 – 22, 2019

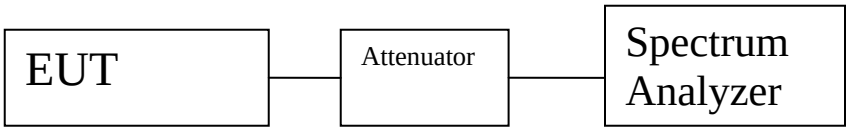

Figure 13: Block Diagram, Occupied Bandwidth Test Setup

Test Data

Frequency MHz	99% Bandwidth MHz	6 dB Bandwidth MHz	Limit KHz
2405	2.365	1.592	≥500 KHz
2440	2.390	1.611	≥500 KHz
2475	2.393	1.618	≥500 KHz

Figure 14: 6 dB Occupied Bandwidth, Test Results

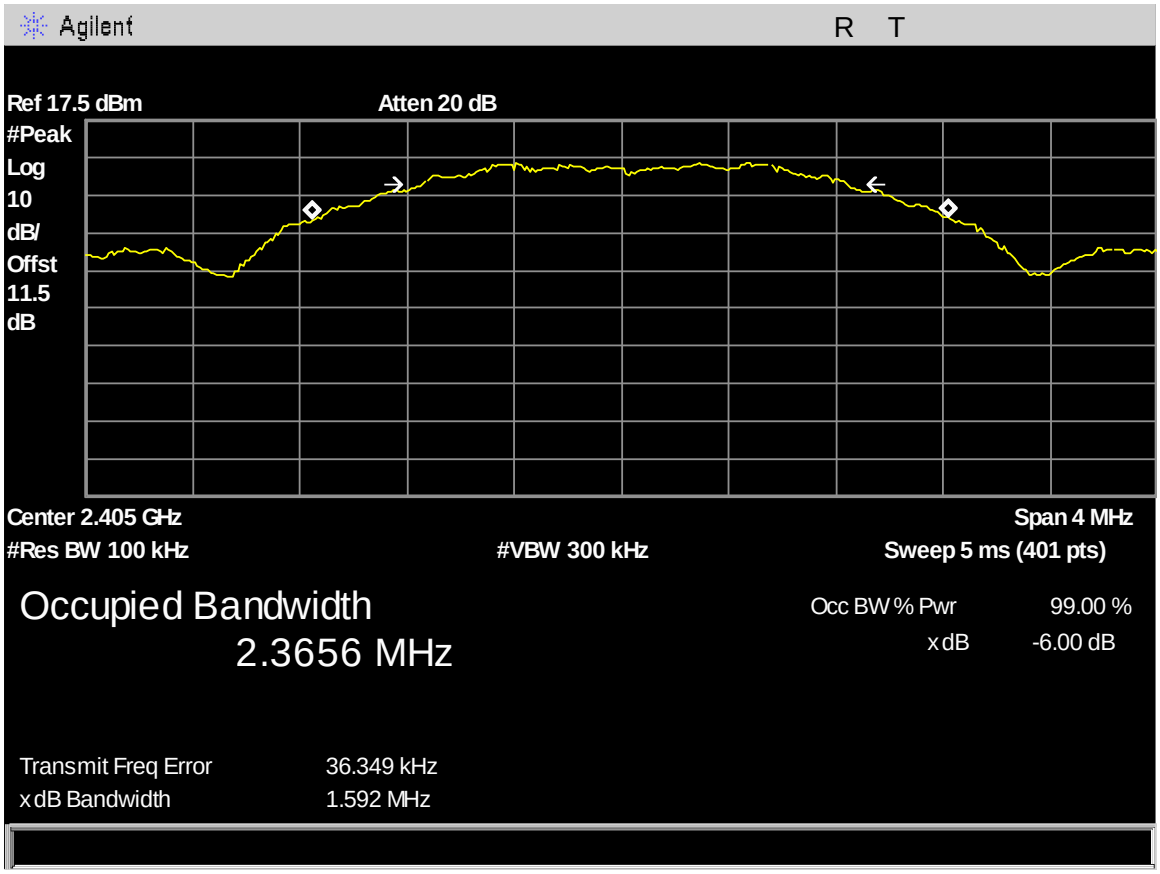

Figure 15: 6 dB Occupied Bandwidth, Low Channel

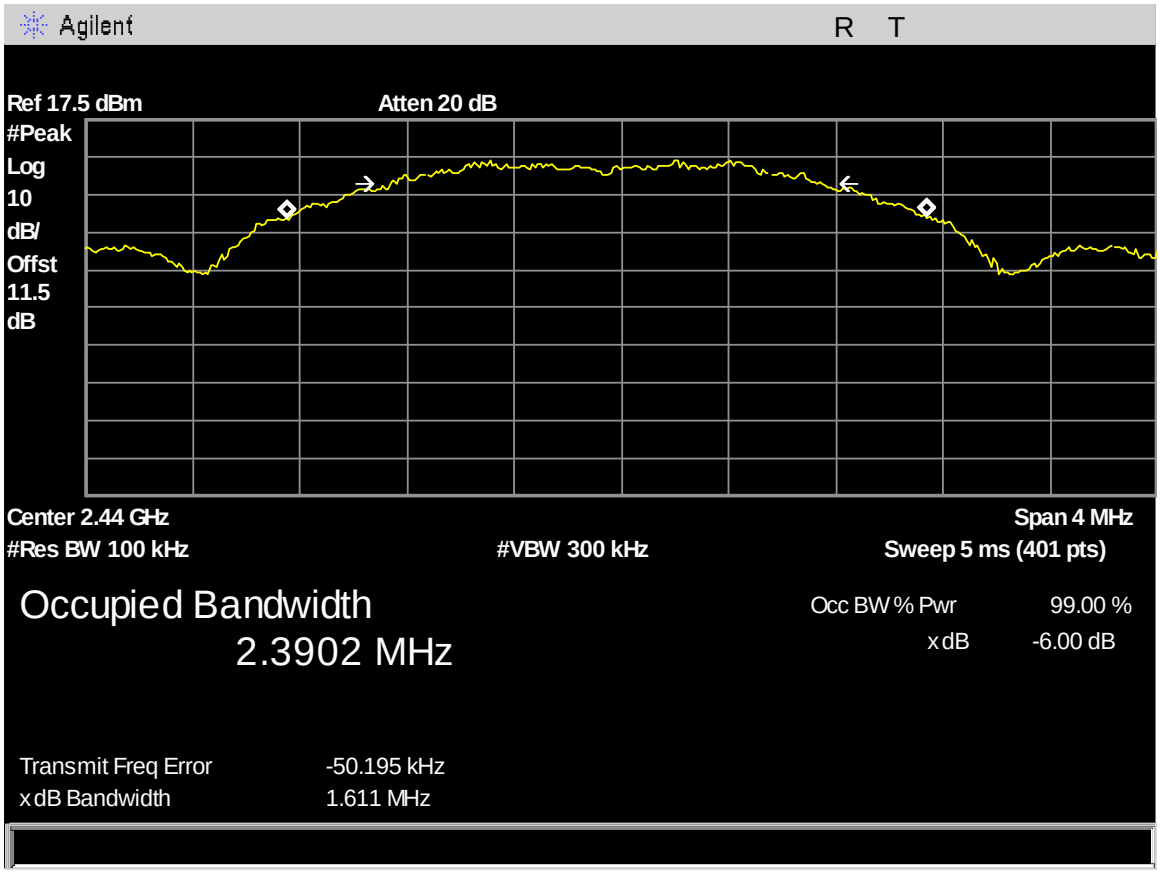

Figure 16: 6 dB Occupied Bandwidth, Mid Channel

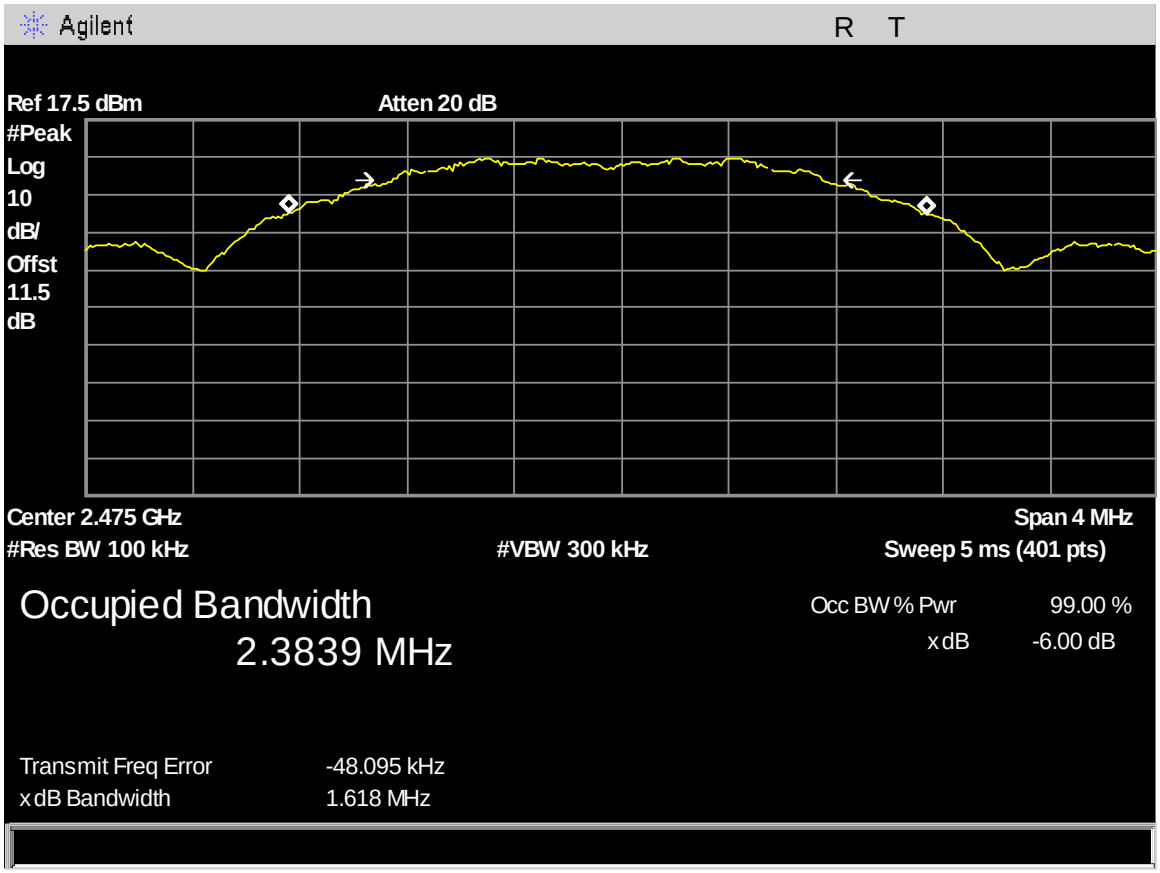

Figure 17: 6 dB Occupied Bandwidth, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(b) Peak Power Output

Test Requirements: **§15.247(b):** The maximum peak output power of the intentional radiator shall not exceed the following:

Digital Transmission Systems (MHz)	Output Limit (Watts)
2400–2483.5	1.000

Figure 18: Output Power Requirements from §15.247(b)

§15.247(c): if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in the 9, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure: The EUT was measured at the low, mid and high channels of each band at the maximum power level. Measurements were taken by connecting antenna port to the Spectrum analyzer via RF cable. Cable low was added into the spectrum analyzer. Measurement was performed as per ASNI C63.10 Section 11.9.1.1.

Test Results: The EUT was **compliant** with the Peak Power Output limits of **§15.247(b)**. No anomalies noted.

Test Engineer: Deepak Giri

Test Dates: August 22 – 24, 2019

Test Data

Frequency MHz	Conducted Power dBm	Antenna Gain dBi	Conducted Power Limit dBm
2405	9.518	1.5	30
2440	10.02	1.5	30
2475	10.61	1.5	30

Figure 19: Peak Output Power, Test Results

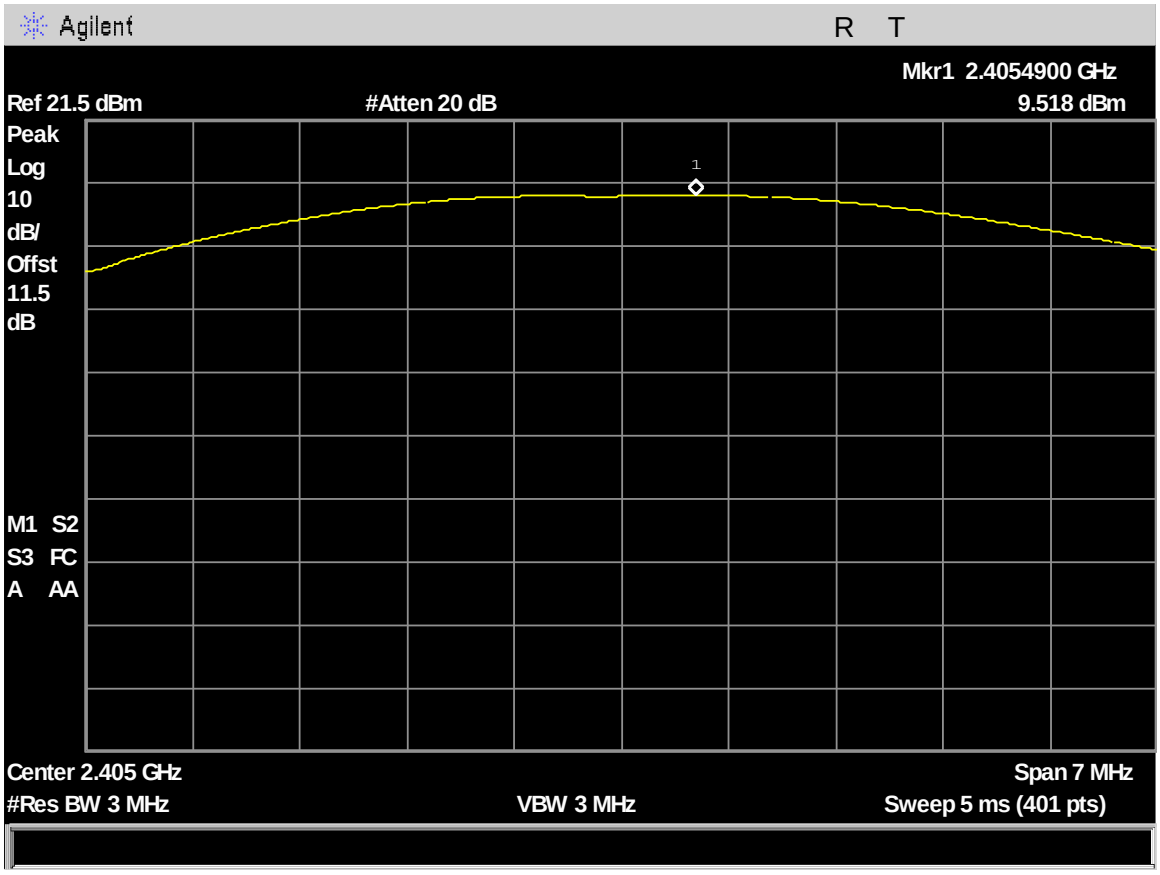

Figure 20: Peak Output Power, Low Channel

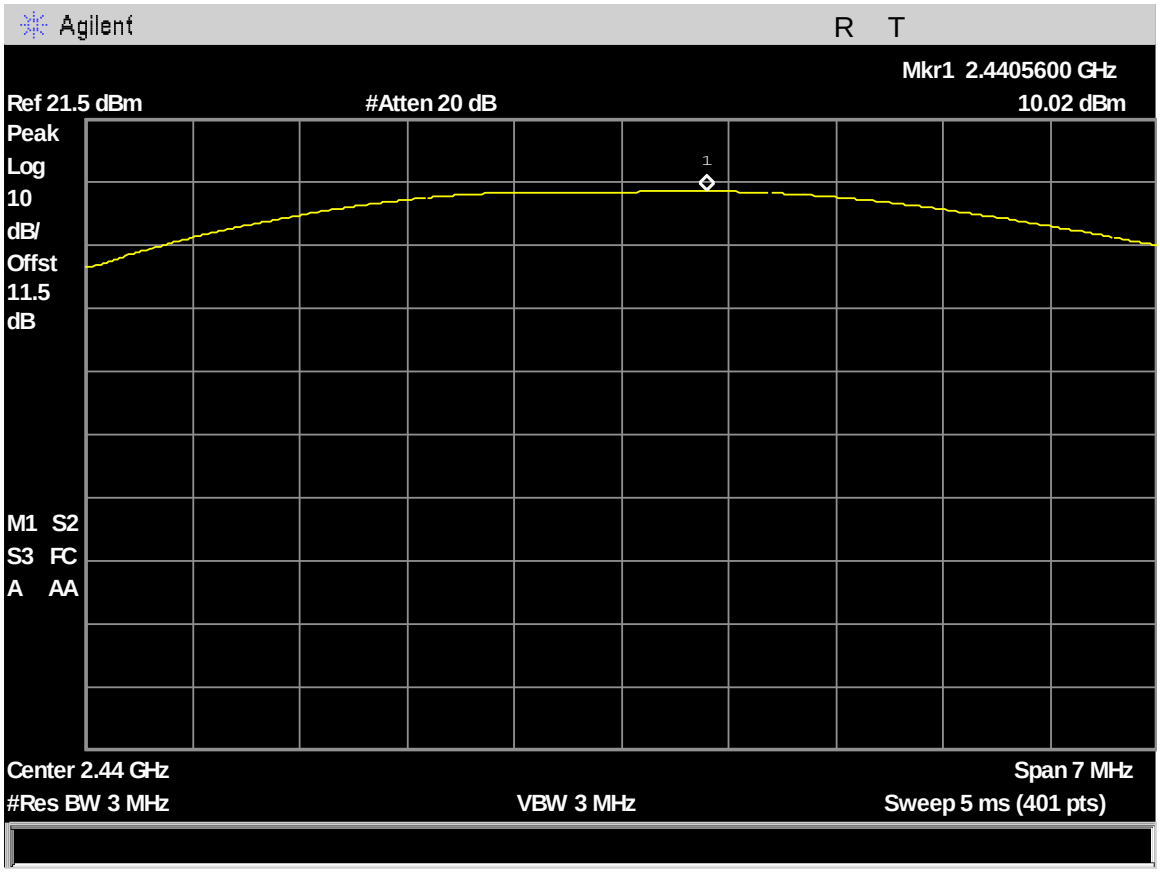

Figure 21: Peak Output Power, Mid Channel

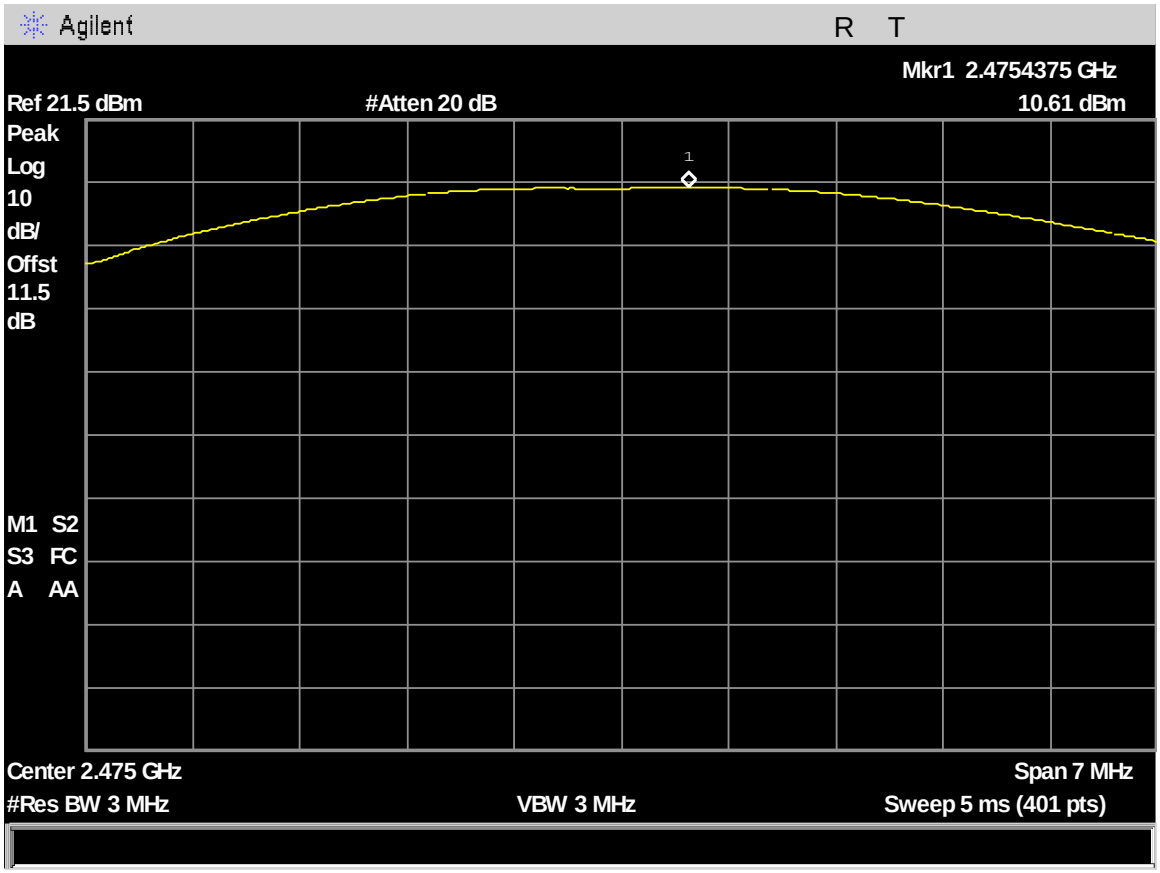

Figure 22: Peak Output Power, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.209 Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475----------	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293----------	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025----------	240–285	3345.8–3358 36.	43–36.5
12.57675–12.57725----------	322–335.4	3600–4400	([2])

Figure 23: Restricted Bands of Operation

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Figure 24:

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Figure 24: Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for antenna correction factor, cable, pre-amp and distance and compared to a 3 m limit line. Emission are investigated up to 25 GHz. Plots shown are maximum emission level achieved by rotating the turn table, moving measuring antenna and changing the polarity of the measuring antenna. Below 1GHz, Peak detector was used and emission close to the limit line by 20dB was evaluated using Quasi-Peak detector. Above 1 GHz, Peak and Average detectors were used and emission close to the limit was investigated accordingly. Radiated emission in the restricted band was performed according to ANSI C63.10-2013 Section 11.12.1.

Final Measurement = Raw Field Strength + Cable Loss + Antenna Factor - Pre-Amp

Test Results: The EUT was **compliant** with the Radiated Spurious Emission limits of **§ 15.247(d) and § 15.209**. No anomalies noted.

Test Engineer: Deepak Giri

Test Date: August 20 – 24, 2019

Test Data

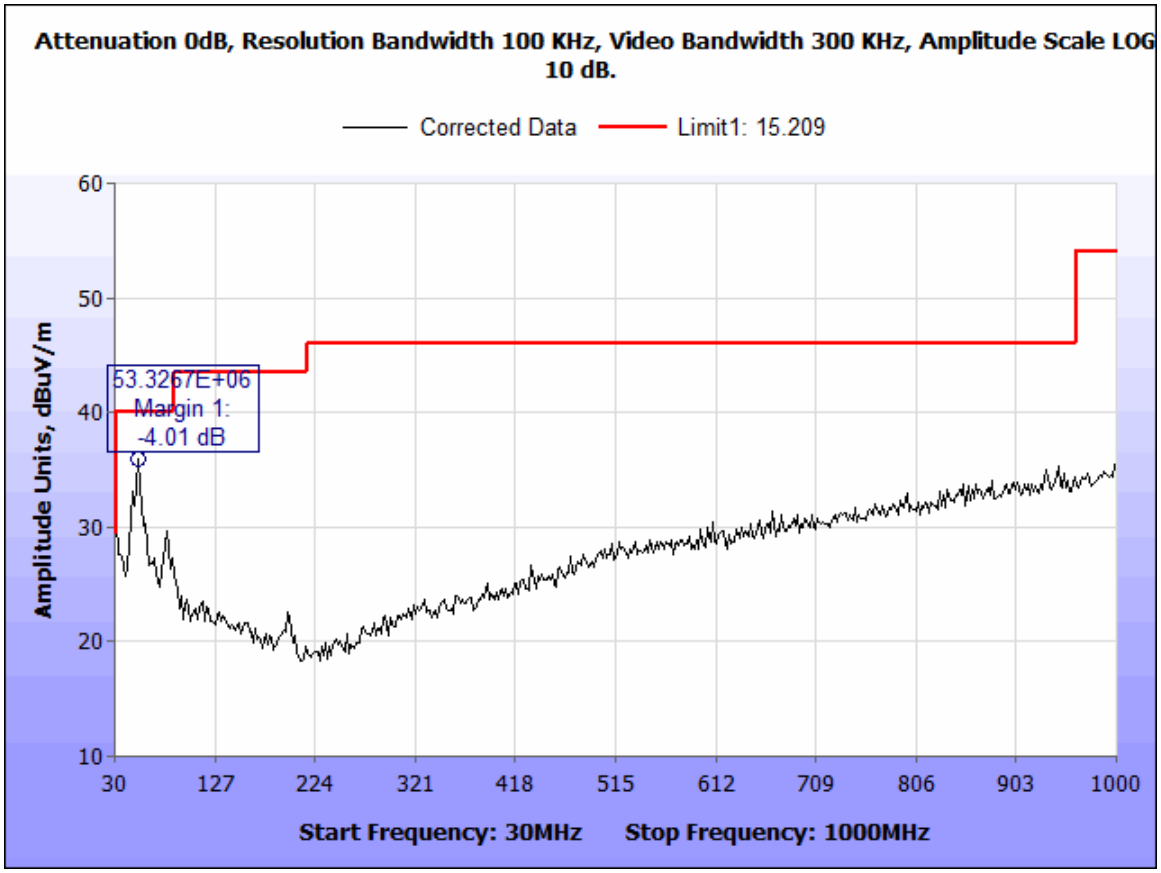

Figure 25: Radiated Spurious Emissions, 30 MHz – 1 GHz, Low Channel

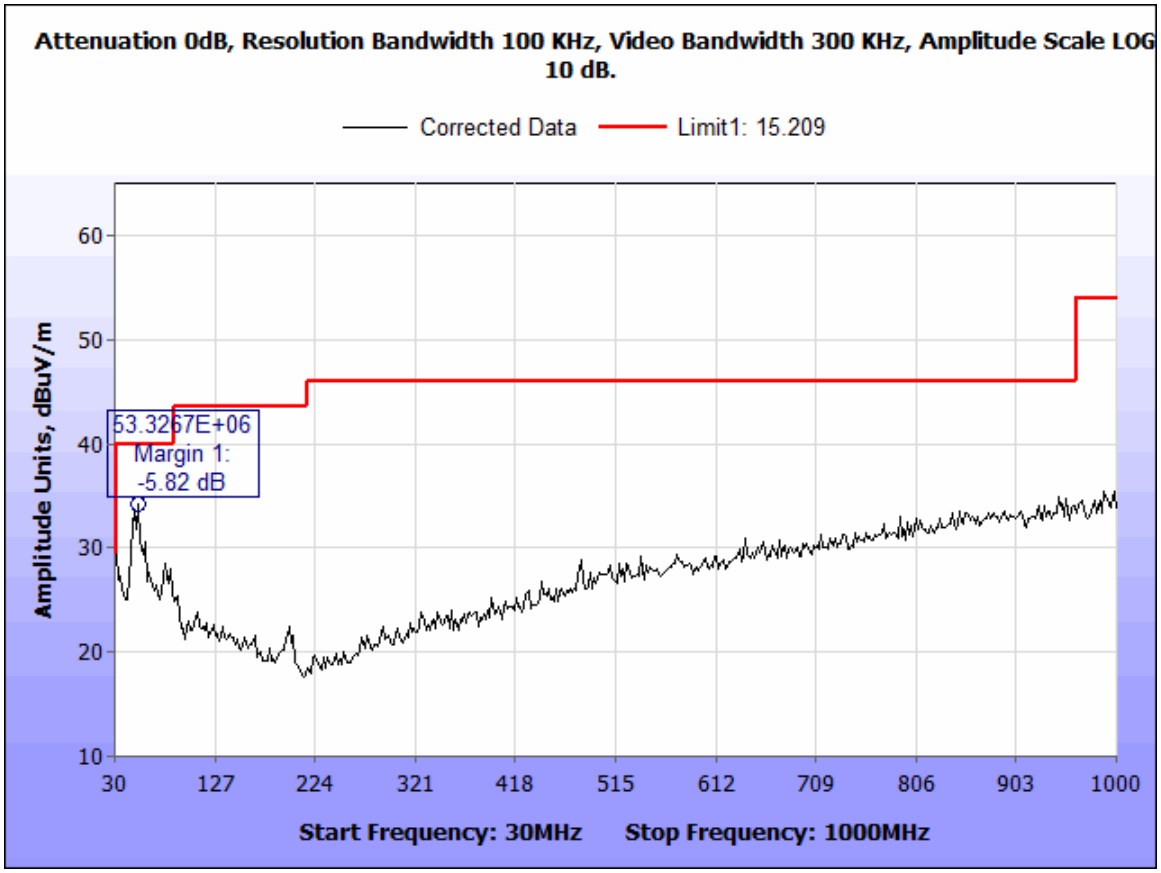

Figure 26: Radiated Spurious Emissions, 30 MHZ – 1 GHz, Mid Channel

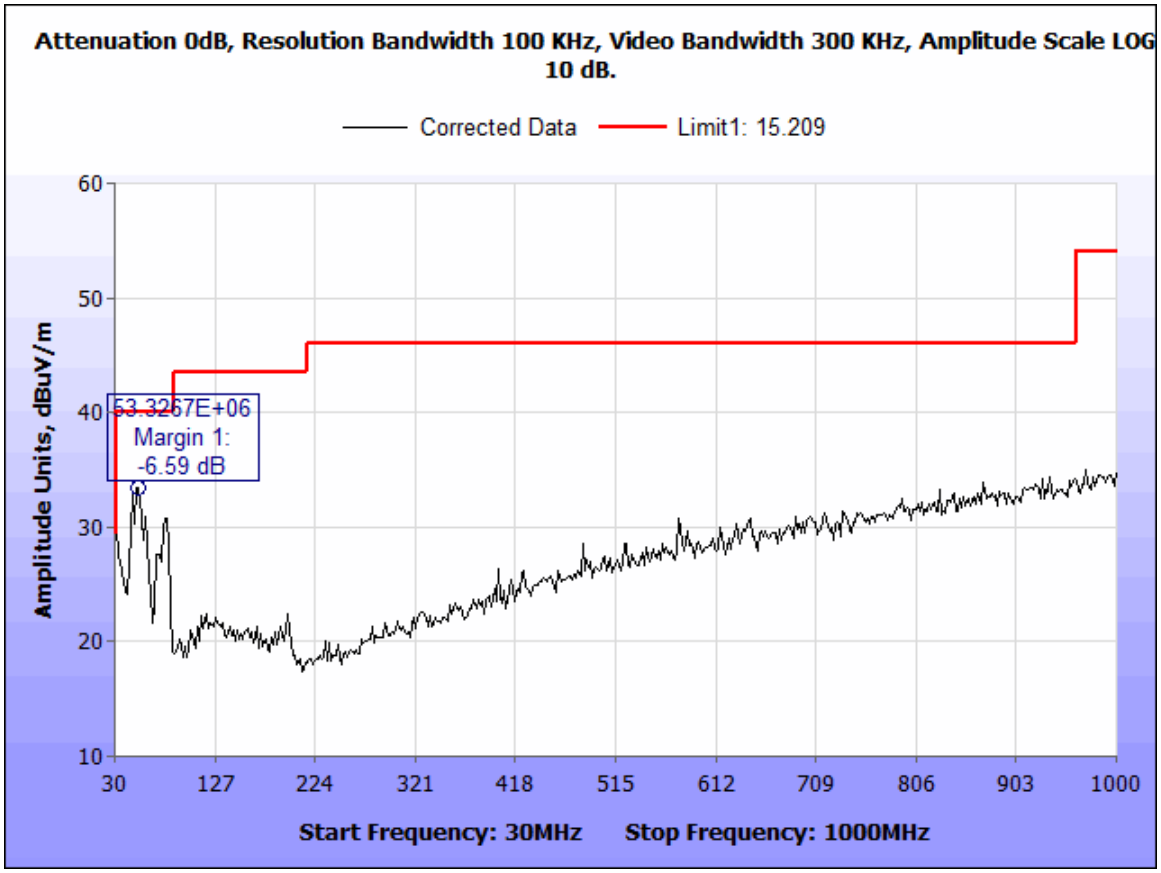

Figure 27: Radiated Spurious Emissions, 30 MHz – 1 GHz High Channel

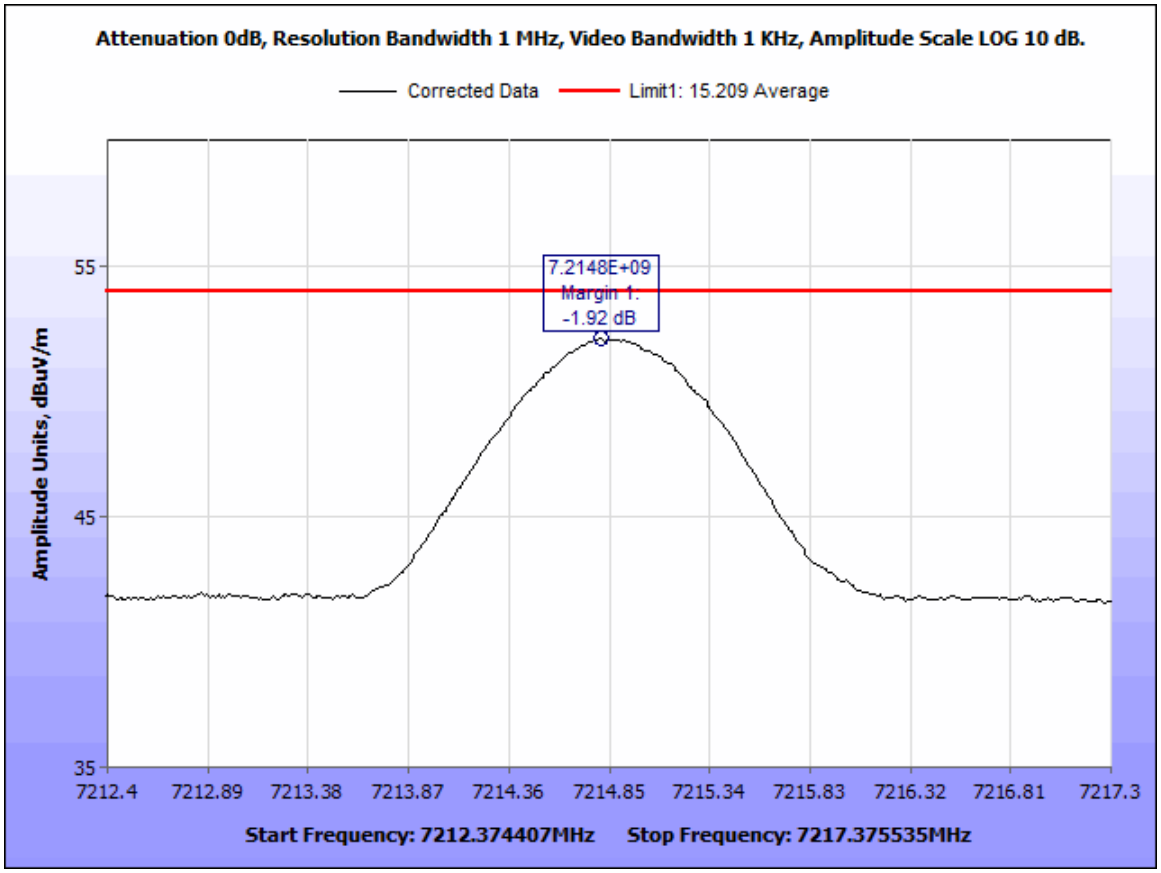

Figure 28: Radiated Spurious Emissions, Low Channel Average 7.2 GHz

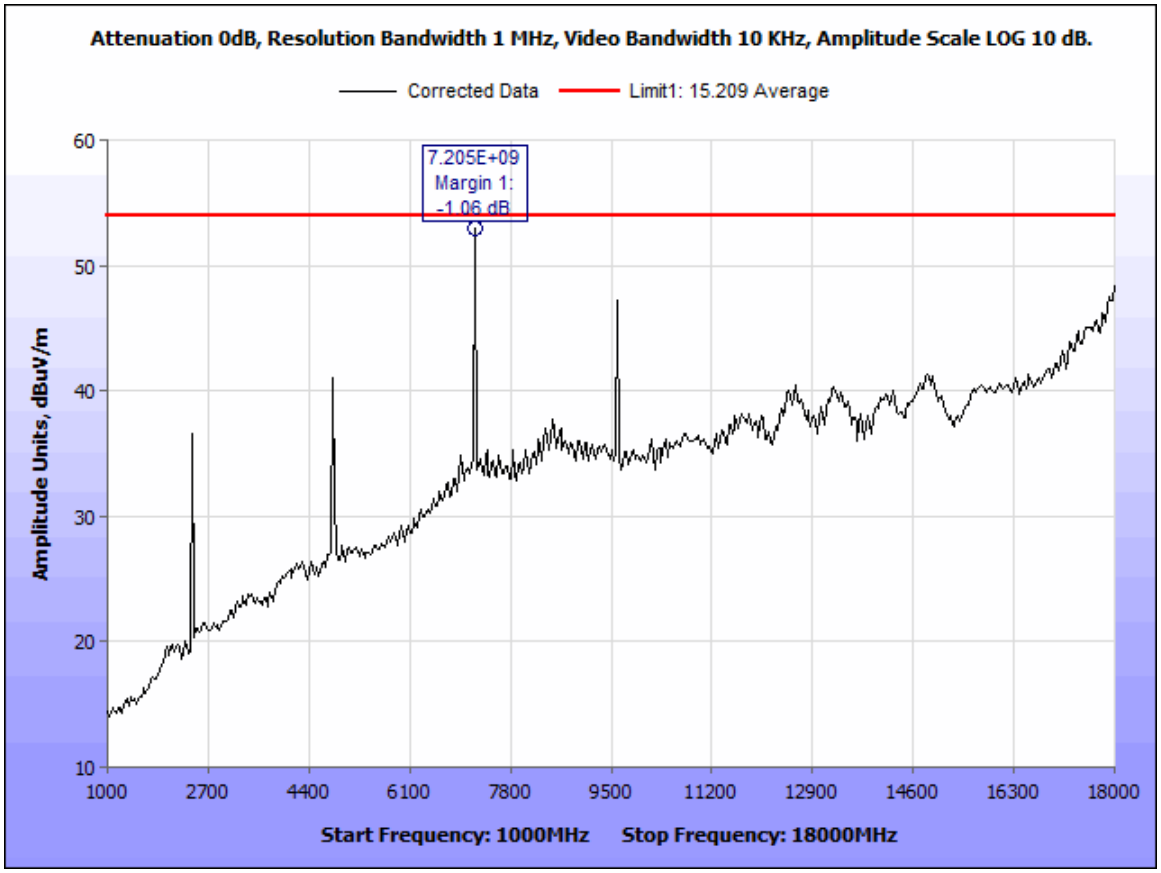

Figure 29: Radiated Spurious Emissions, 1 GHz – 18 GHz, Low Channel Average

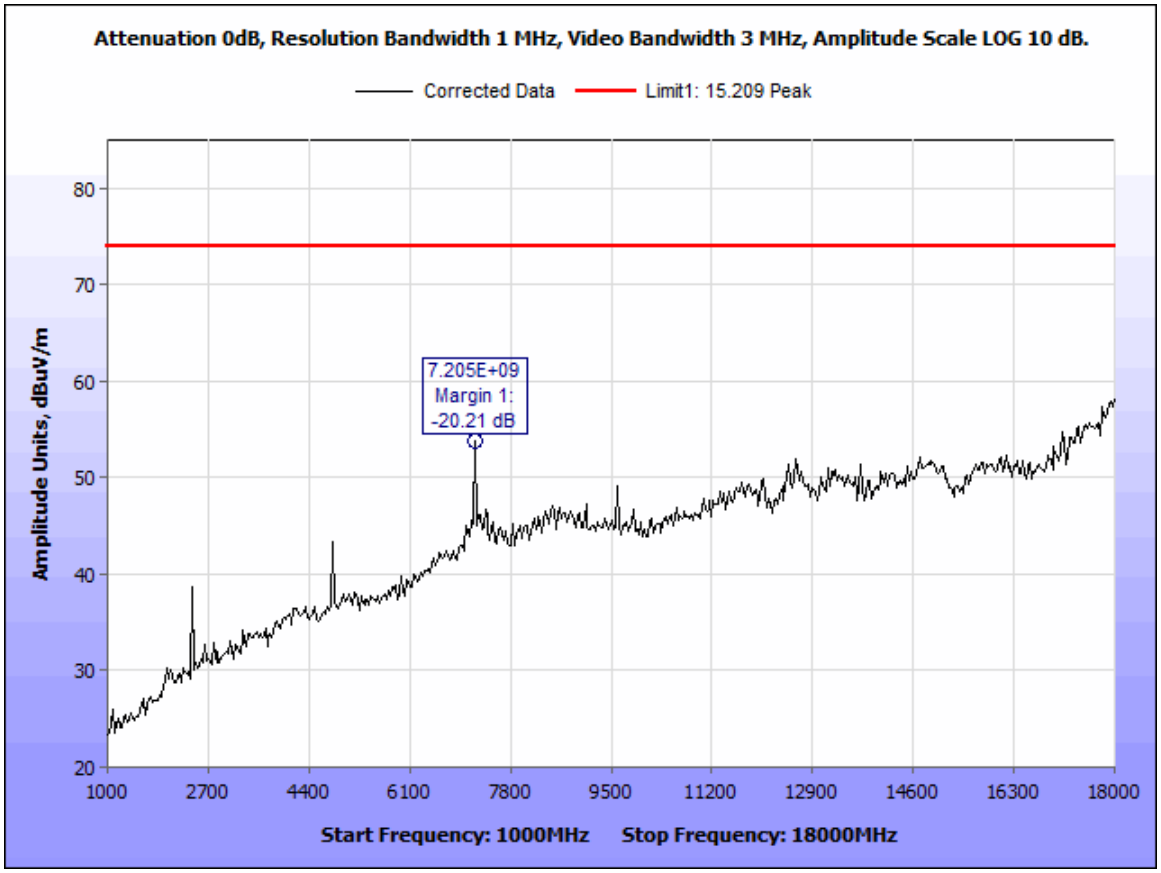

Figure 30: Radiated Spurious Emissions, 1 GHz – 18 GHz, Low Channel Peak

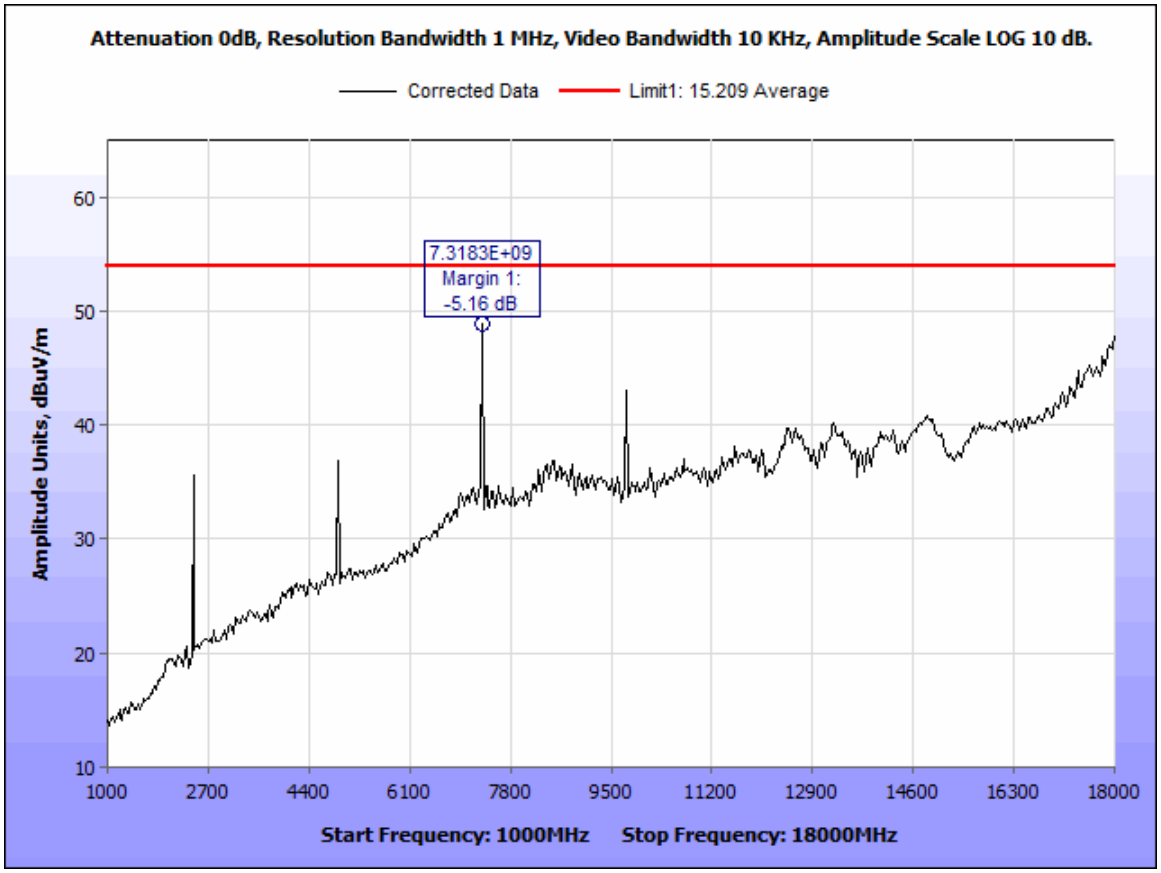

Figure 31: Radiated Spurious Emissions, 1 GHz – 18 GHz, Mid Channel Average

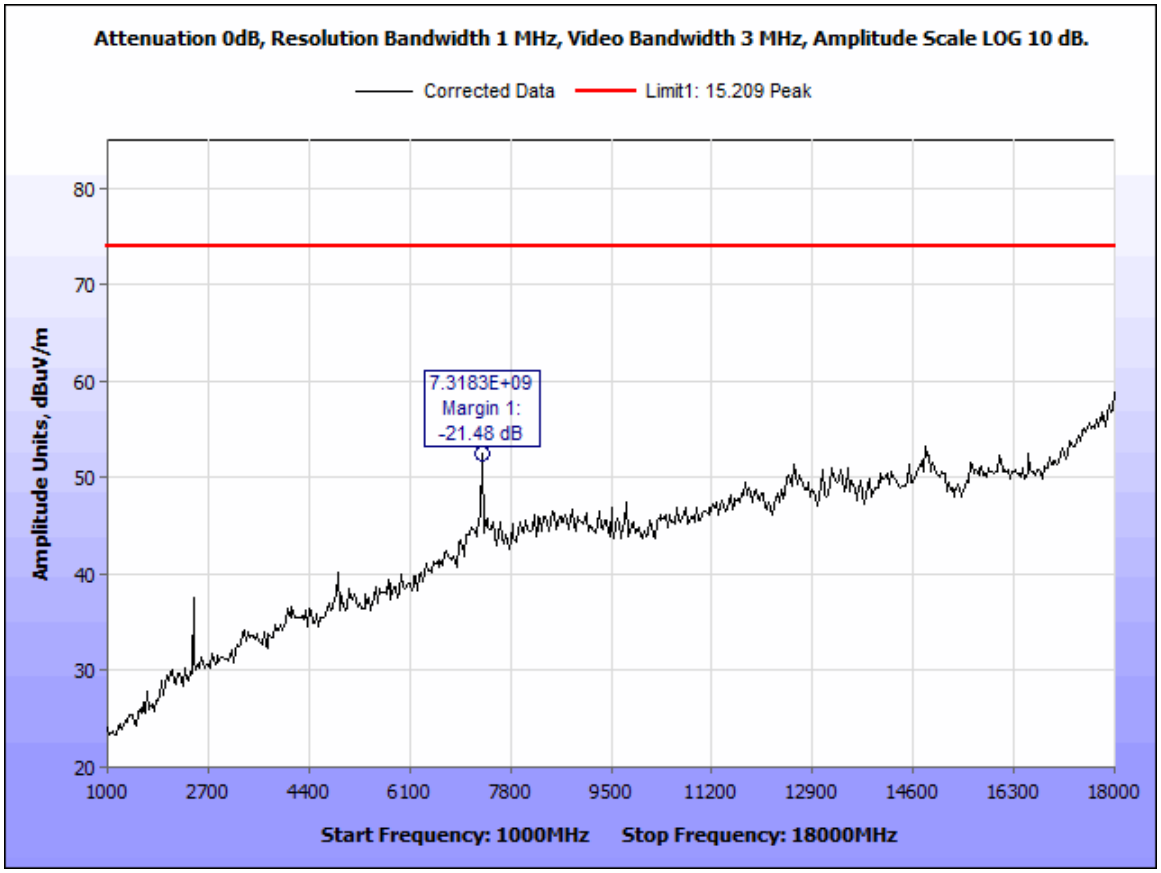

Figure 32: Radiated Spurious Emissions, 1 GHz – 18 GHz Mid Channel Peak

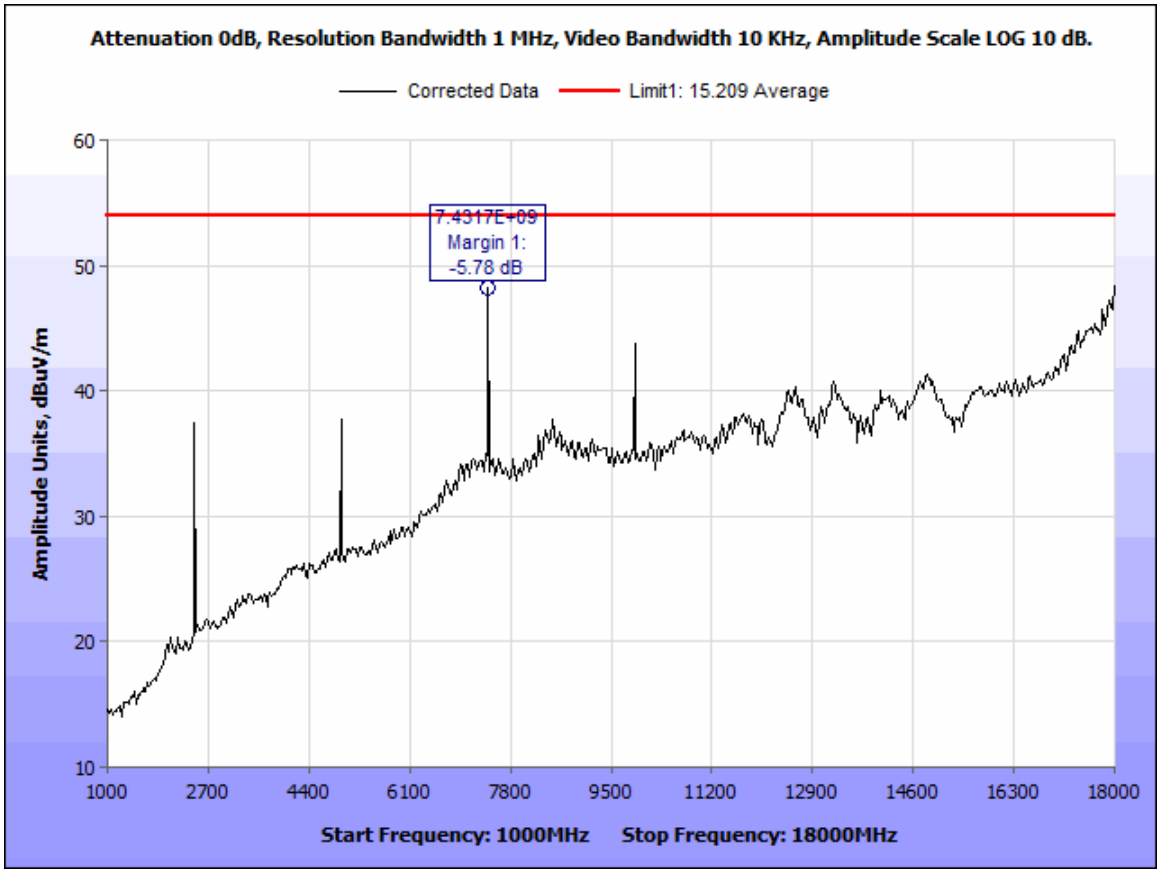

Figure 33: Radiated Spurious Emissions, 1 GHz – 18 GHz, High Channel Average

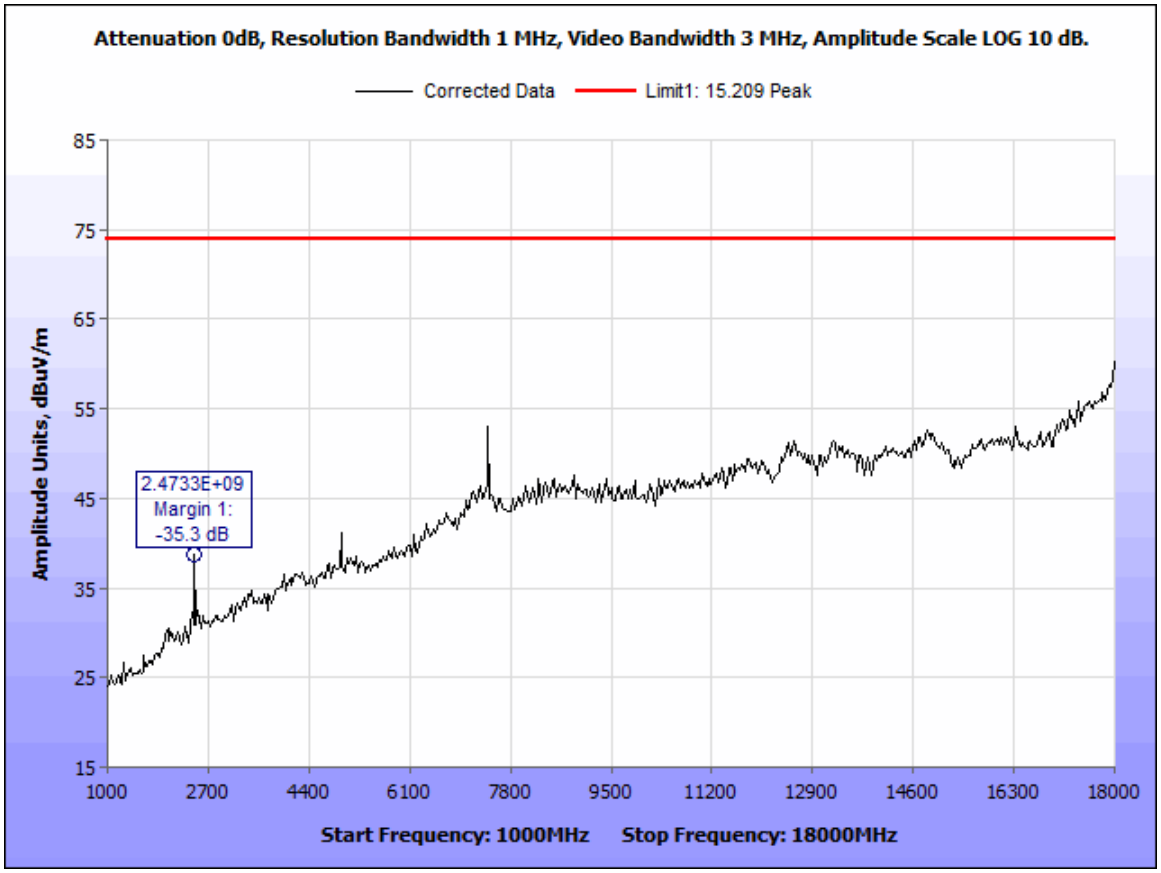

Figure 34: Radiated Spurious Emissions, 1 GHz – 18 GHz, High Channel Peak

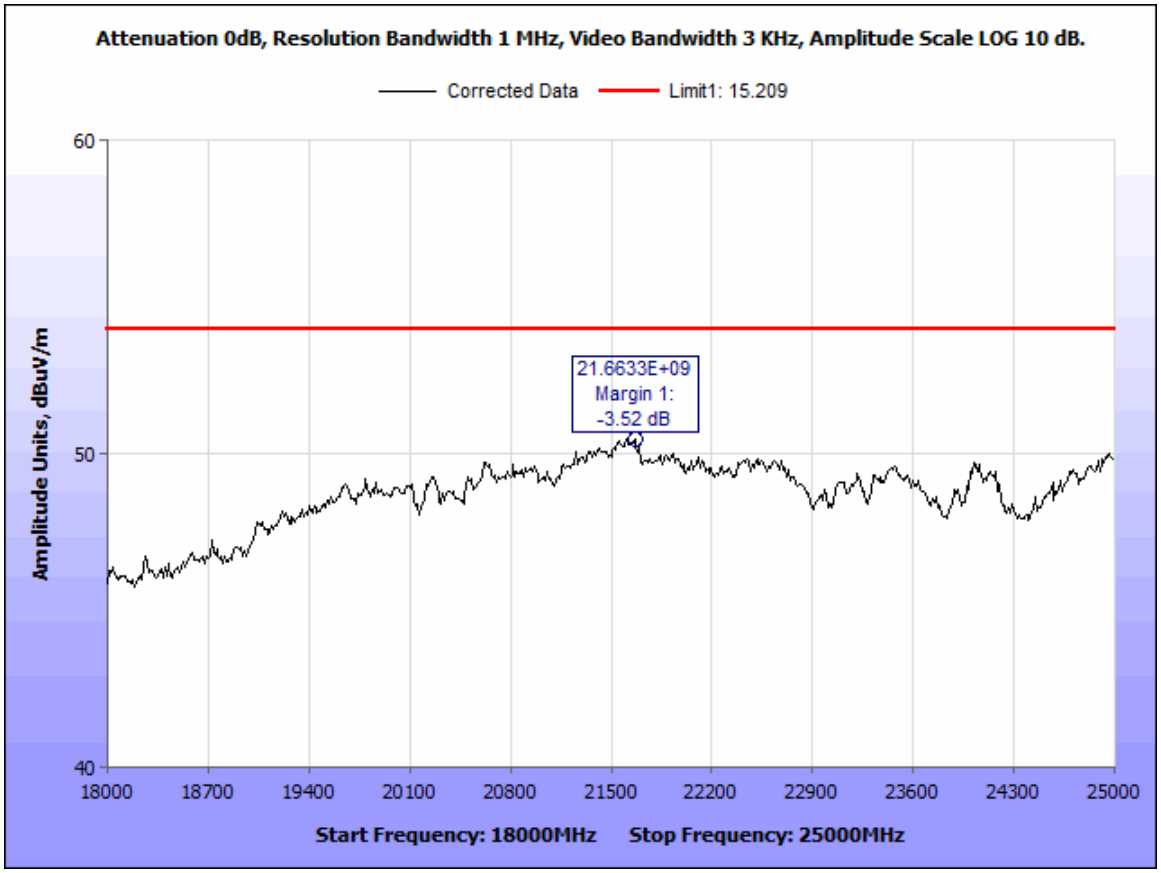

Figure 35: Radiated Spurious Emissions, 18 GHz – 25 GHz, Low Channel Average

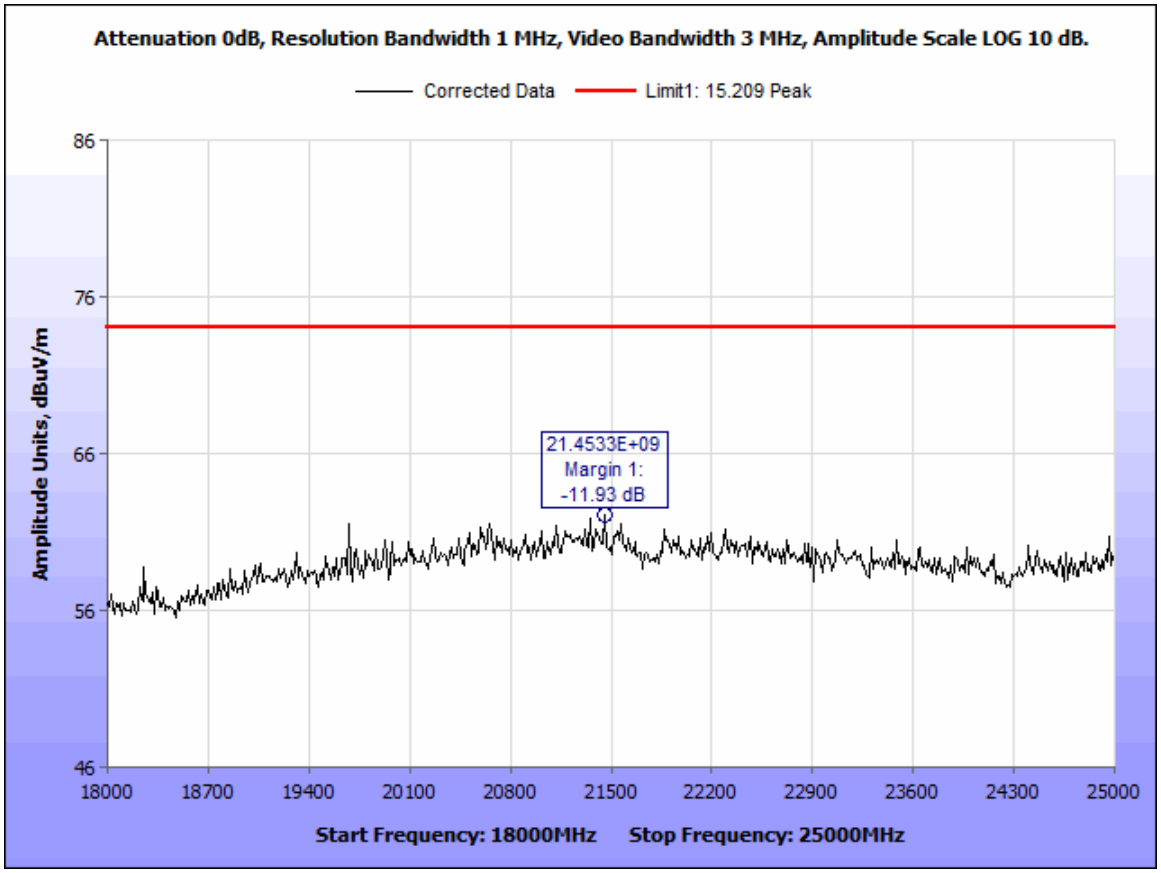

Figure 36: Radiated Spurious Emissions, 18 GHz – 25 GHz, Low Channel Peak

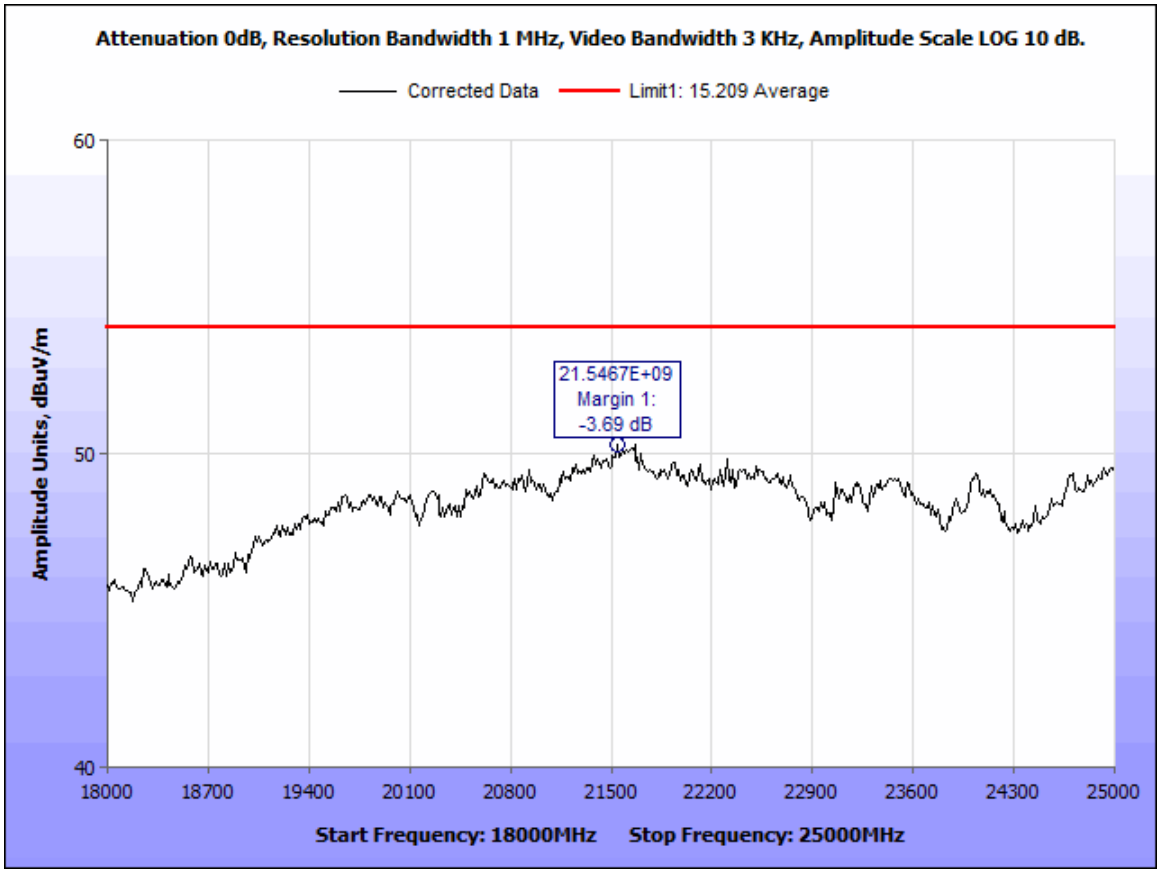

Figure 37: Radiated Spurious Emissions, 18 GHz – 25 GHz Mid Channel Average

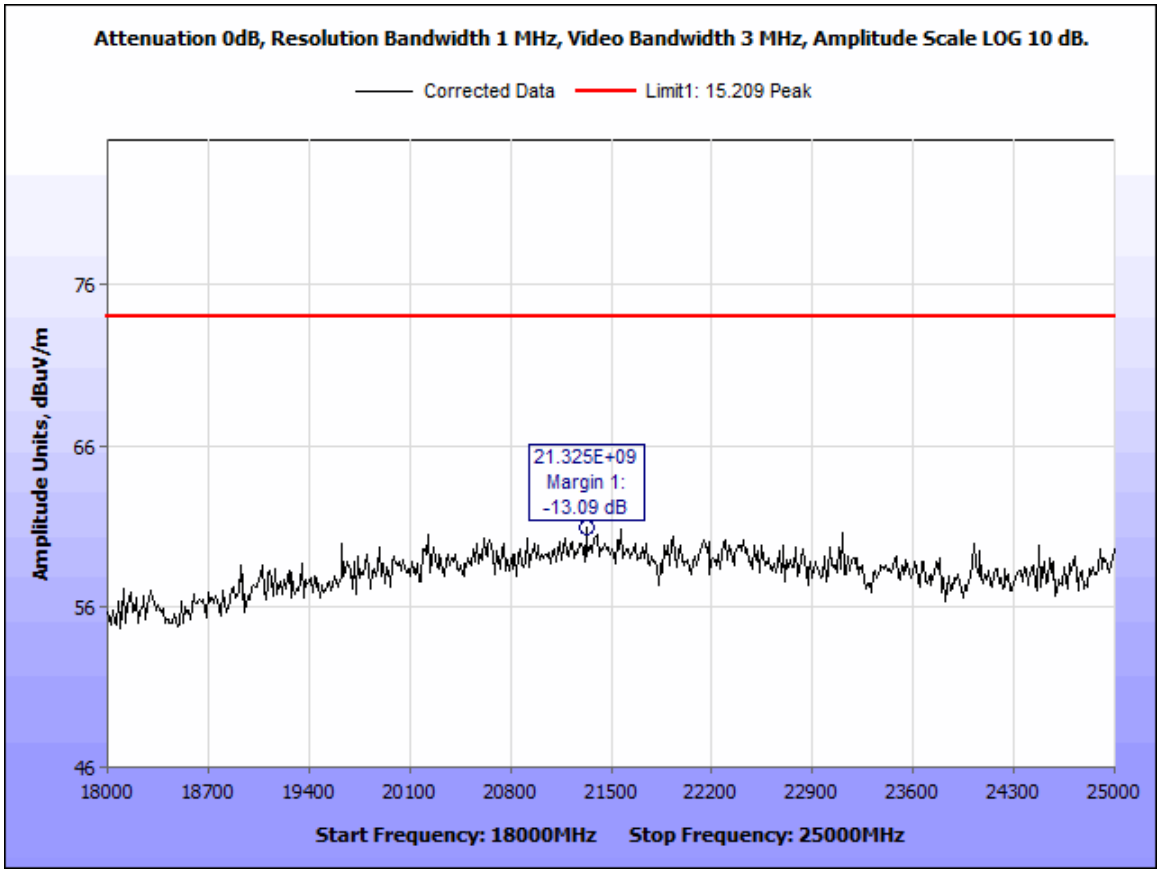

Figure 38: Radiated Spurious Emissions, 18 GHz – 25 GHz, Mid Channel Peak

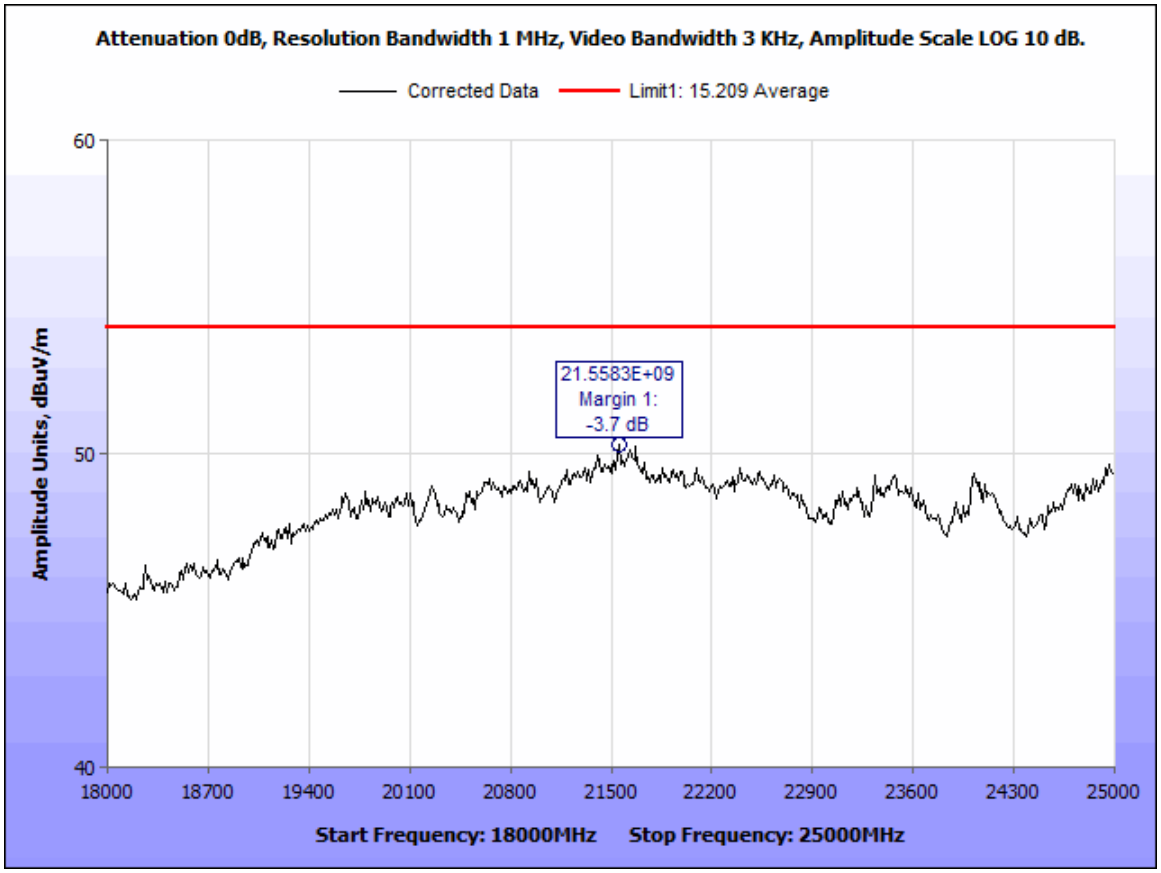

Figure 39: Radiated Spurious Emissions, 18 GHz – 25 GHz, High Channel Average

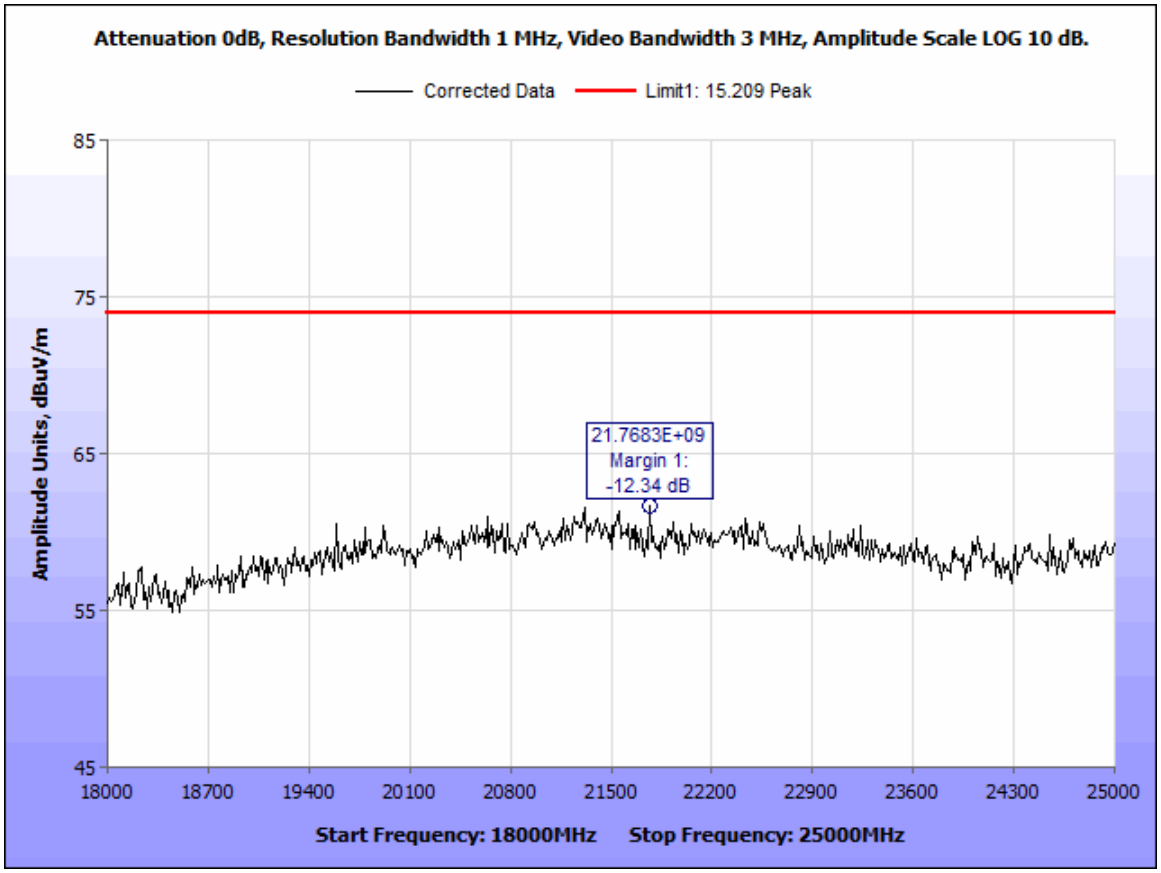

Figure 40: Radiated Spurious Emissions, 18 GHz – 25 GHz, High Channel Peak

Radiated Band Edge Measurements

Test Procedures: The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for antenna correction factor, cable loss and distance and compared to a 3 m limit line. Measurement was performed in accordance with ANSI C63.10 2013 band edge measurement.

Test Data

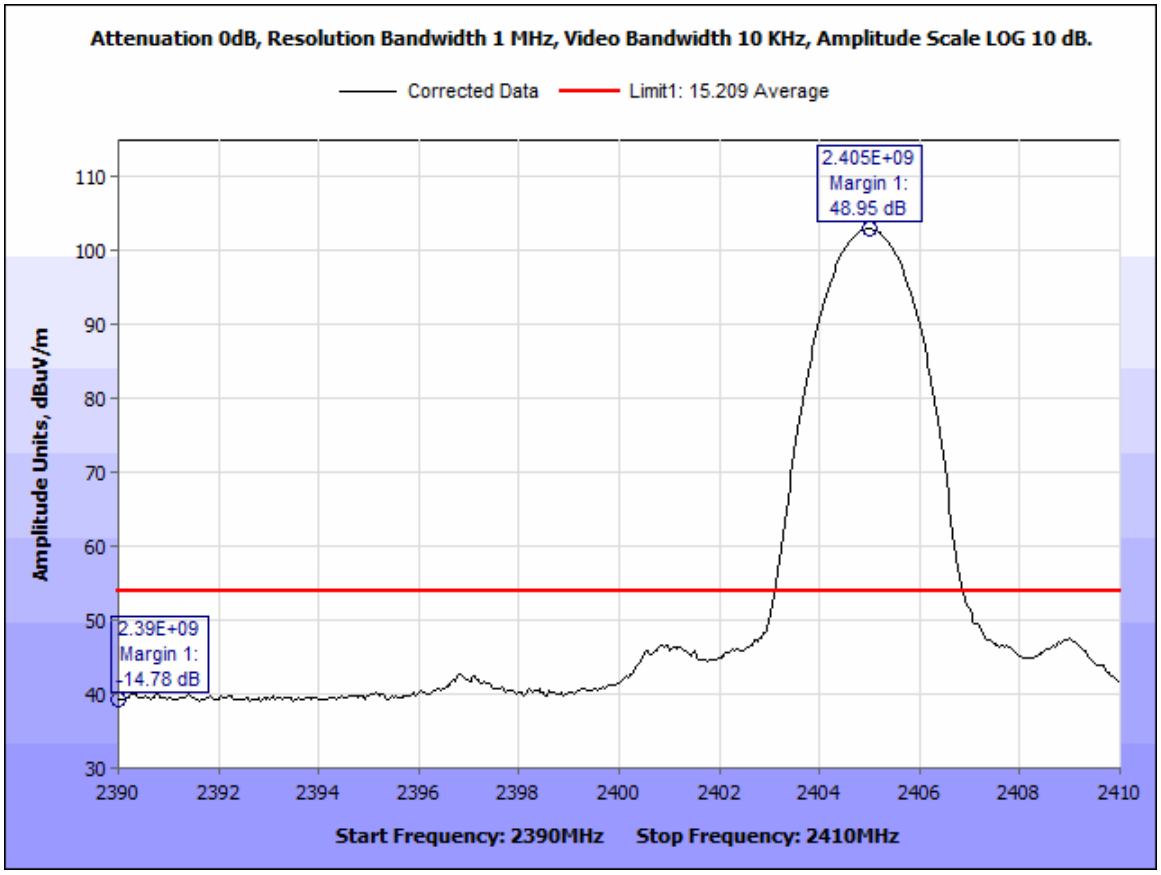

Figure 41: Radiated Band Edge, Low Channel Restricted Band Edge Average

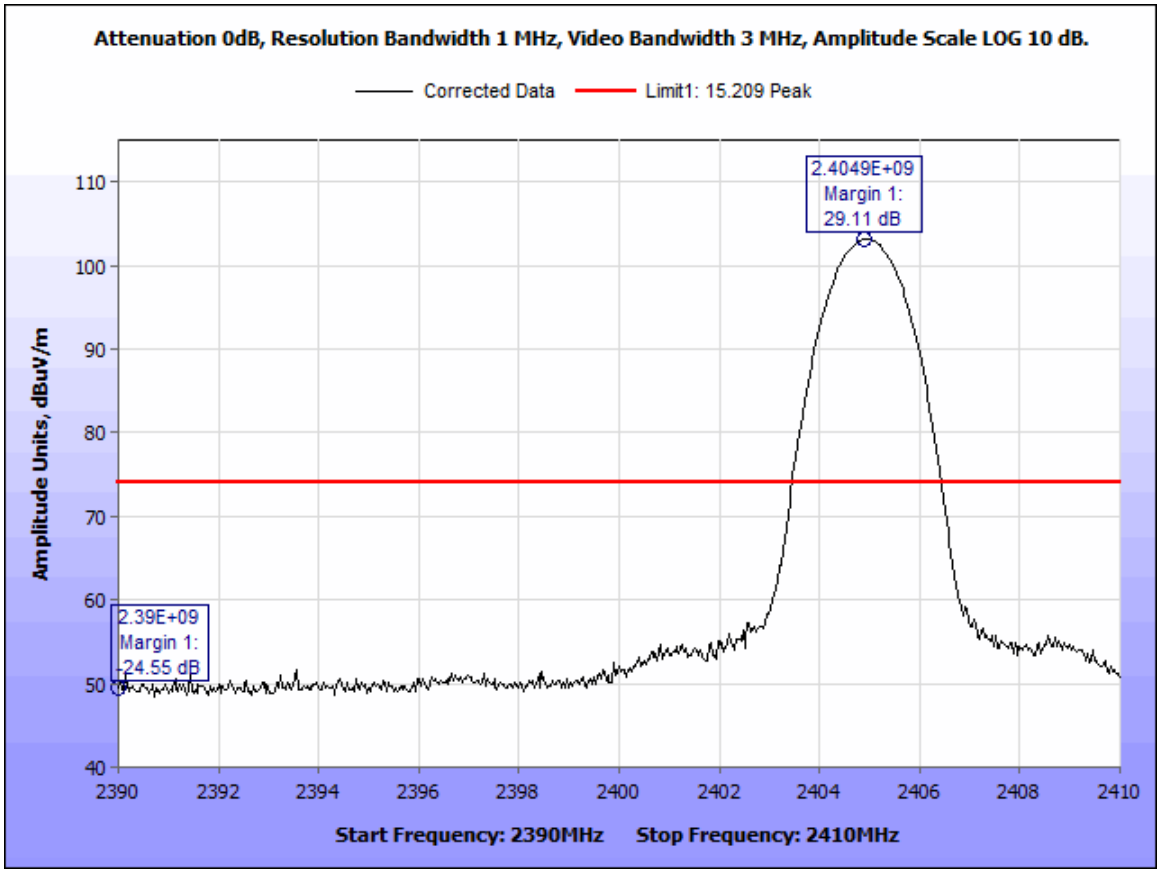

Figure 42: Radiated Band Edge, Low Channel Restricted Band Edge Peak

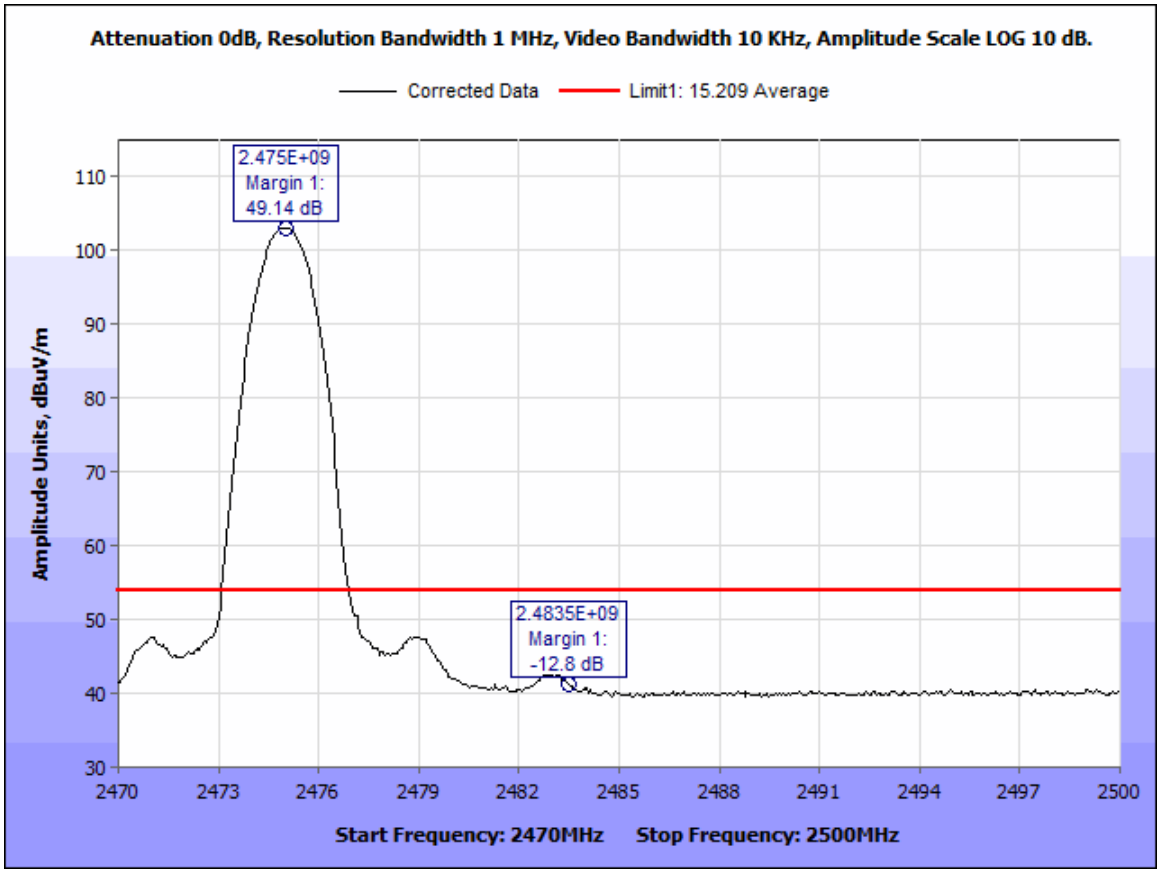

Figure 43: Radiated Band Edge, High Channel Average

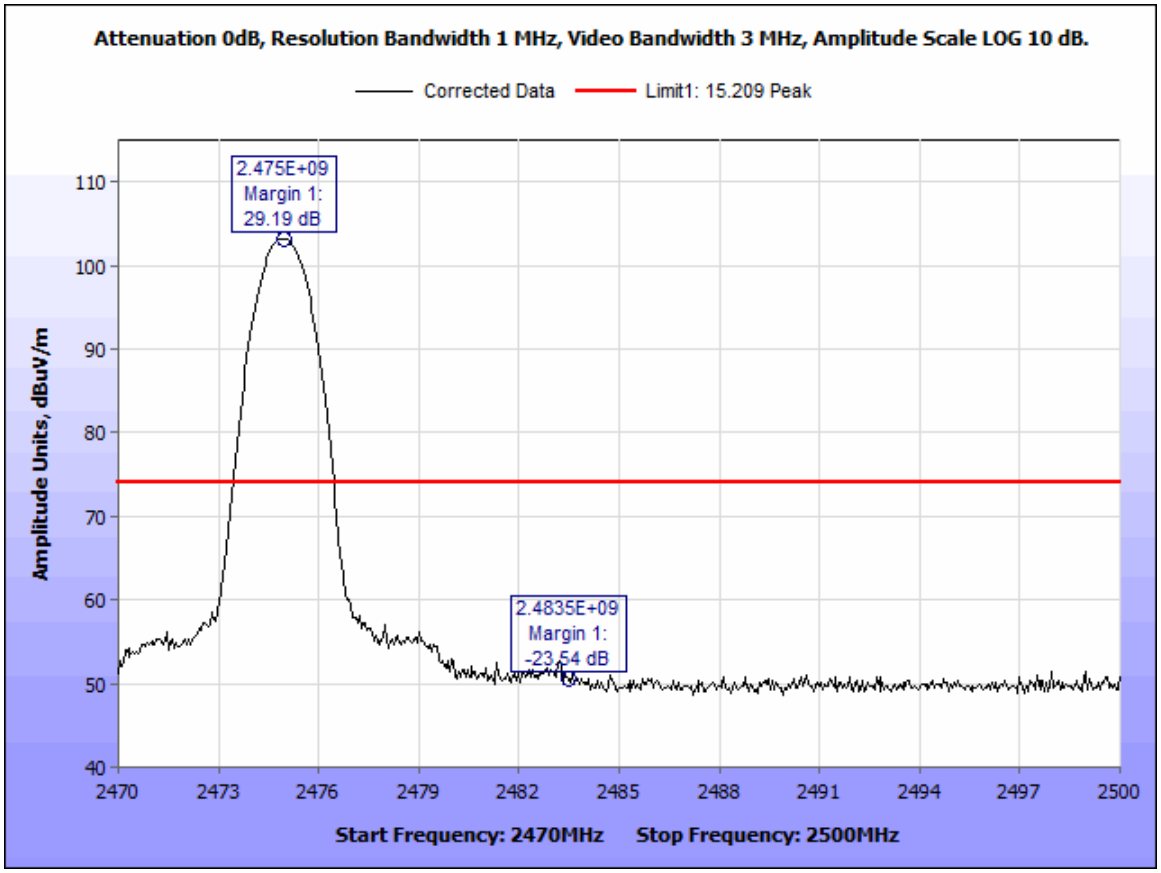

Figure 44: Radiated Band Edge, High Channel Restricted Band Edge Peak

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(d) Spurious Emissions in Non-restricted Bands

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Measurement was performed on low, mid and high channel. Cable loss was added in the measurement. Since the power was measured using maximum Peak method stated in Section 11.9.1 of ANSI C63.10-2013, the limit stated in Section 11.11.1(a) applies.

Test Results: The EUT was **compliant** with the Spurious Emission limits of **§15.247(d)**. No anomalies noted.

Test Engineer: Deepak Giri

Test Date: August 24, 2019

Test Data

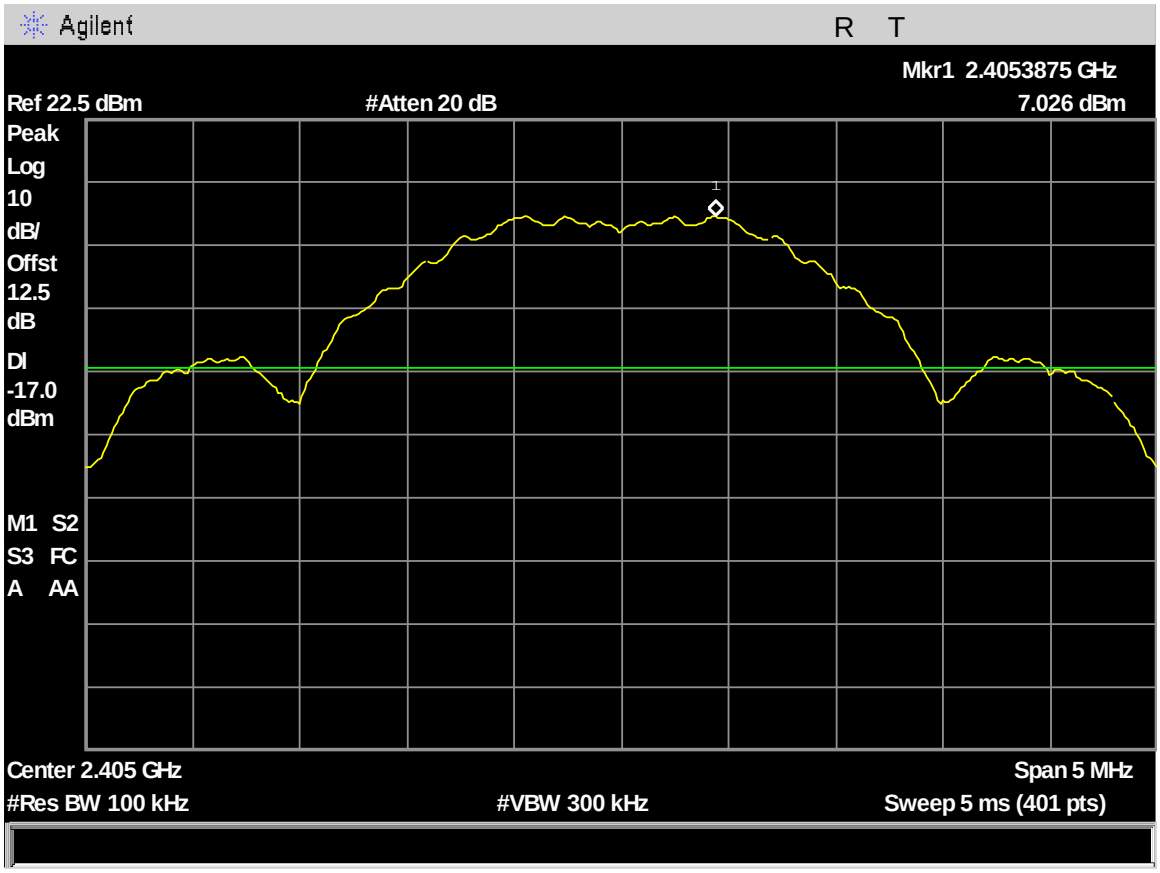

Figure 45: RF Conducted Spurious Emission Reference Level Low Channel

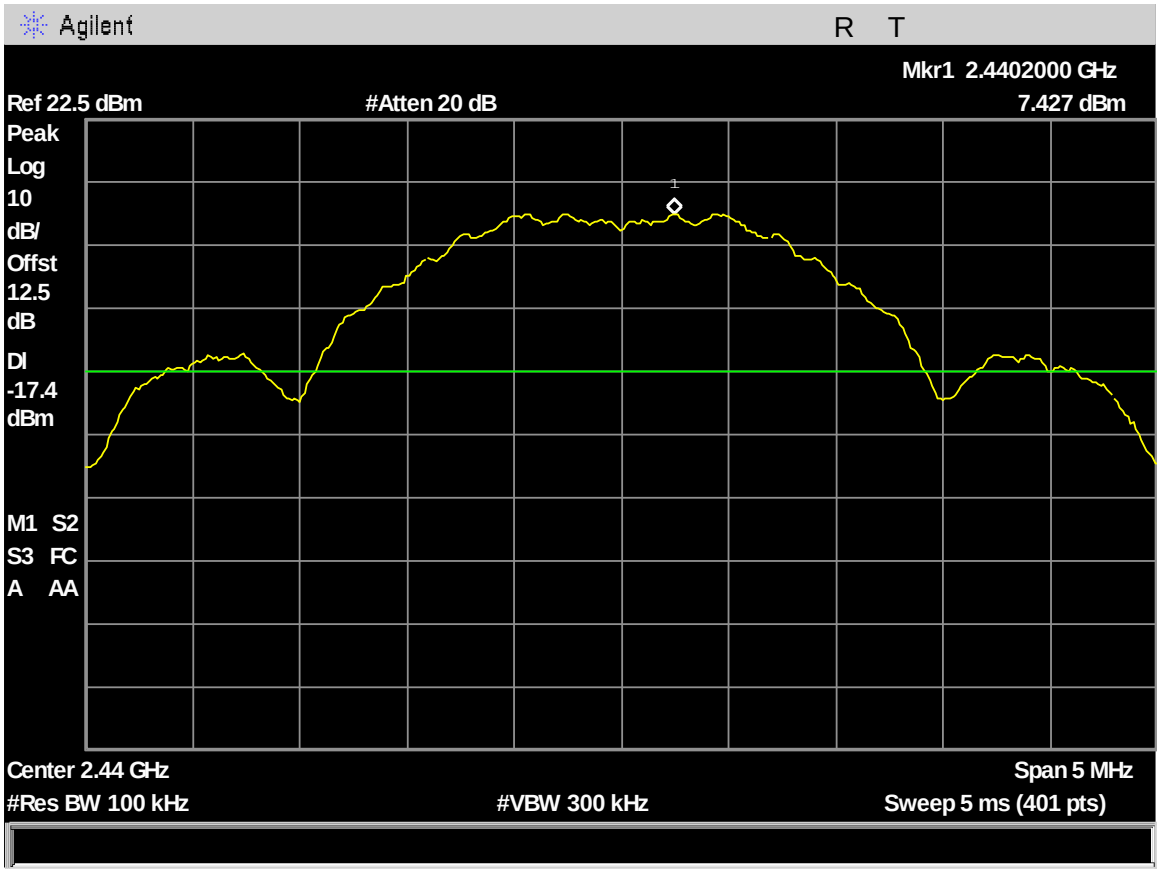

Figure 46: RF Conducted Spurious Emission Reference Level Mid Channel

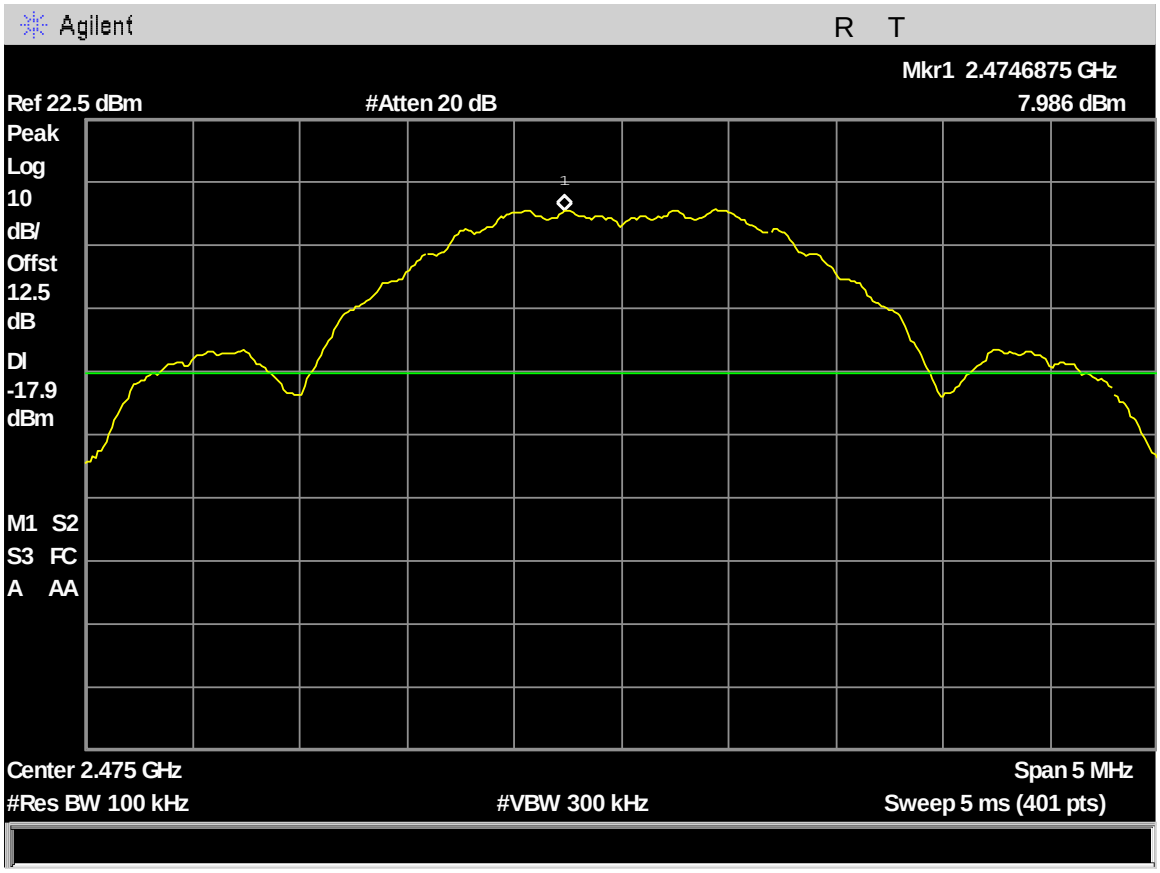

Figure 47: RF Conducted Spurious Emission Reference Level High Channel

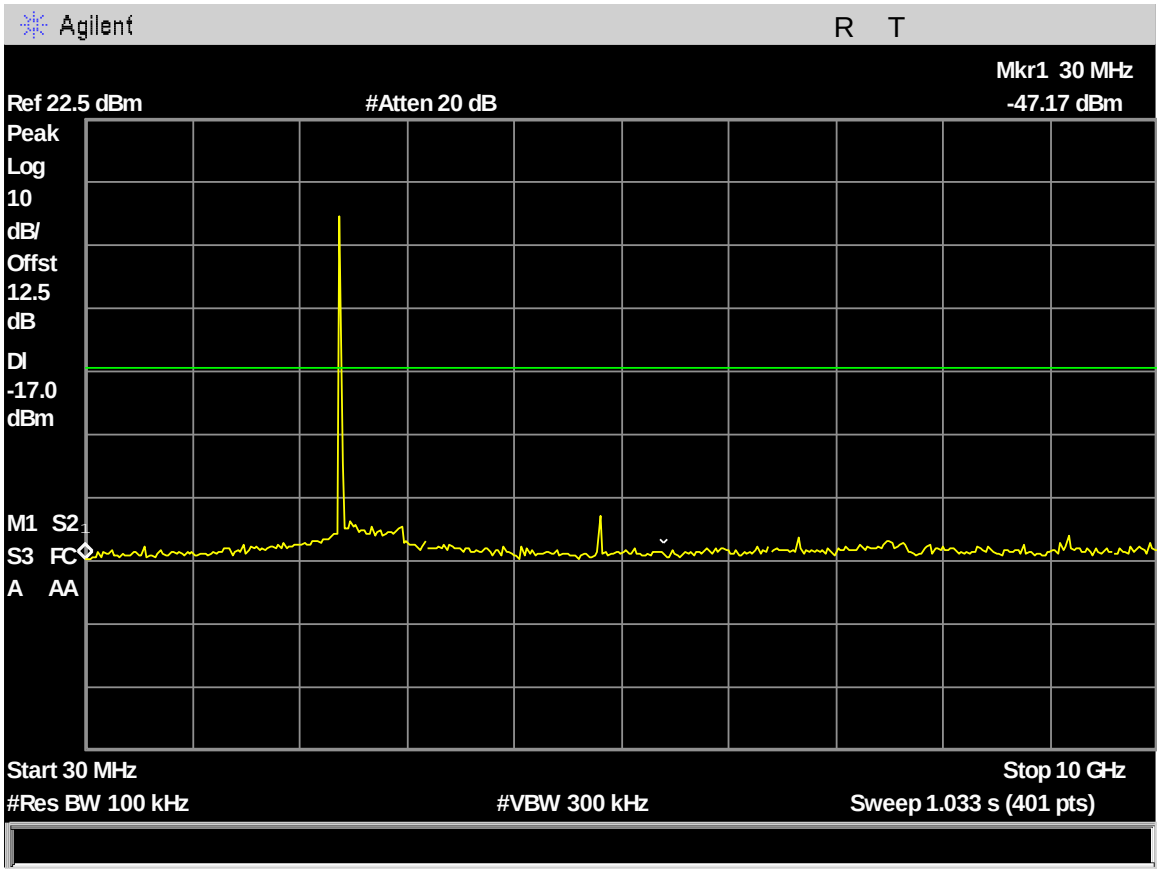

Figure 48: 30 MHz – 10 GHz RF Conducted Spurious Emission Low Channel

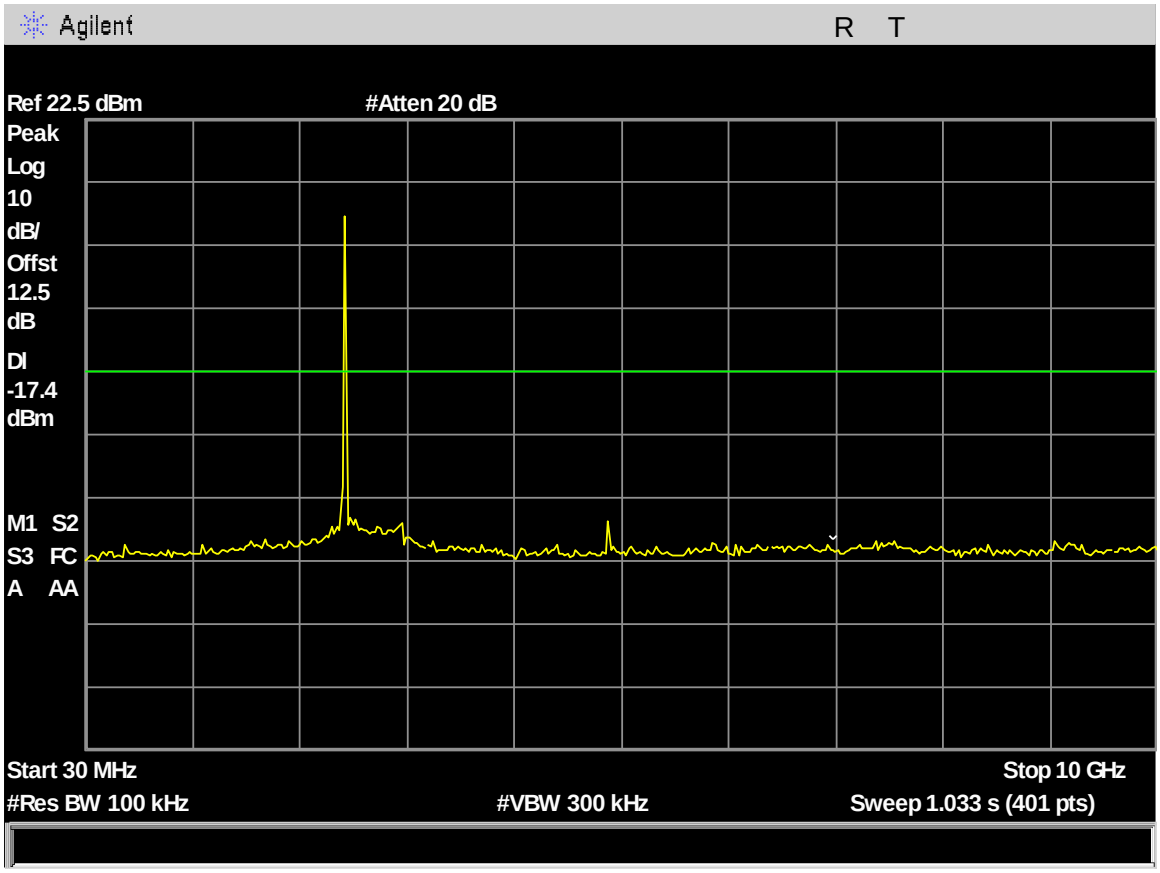

Figure 49: 30 MHz – 10 GHz RF Conducted Spurious Emission Mid Channel

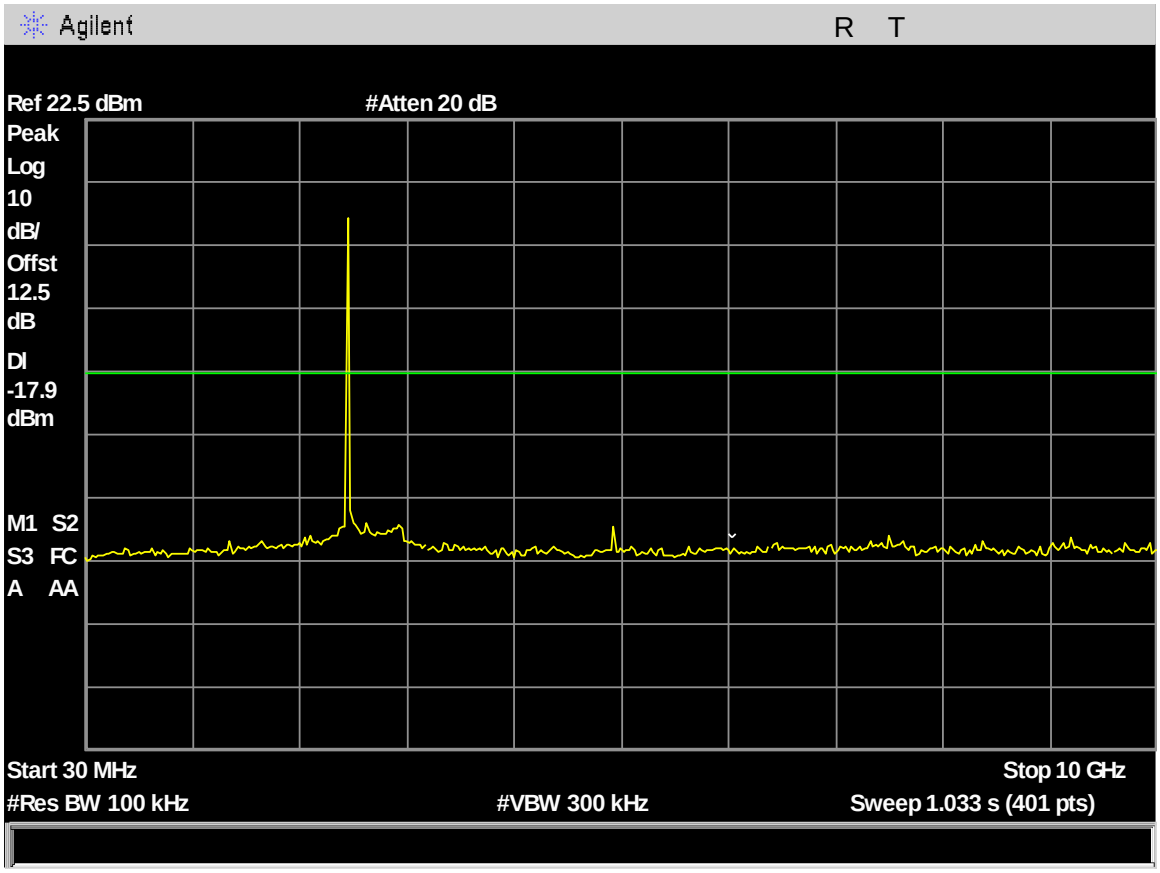

Figure 50: 30 MHz – 10 GHz RF Conducted Spurious Emission High Channel

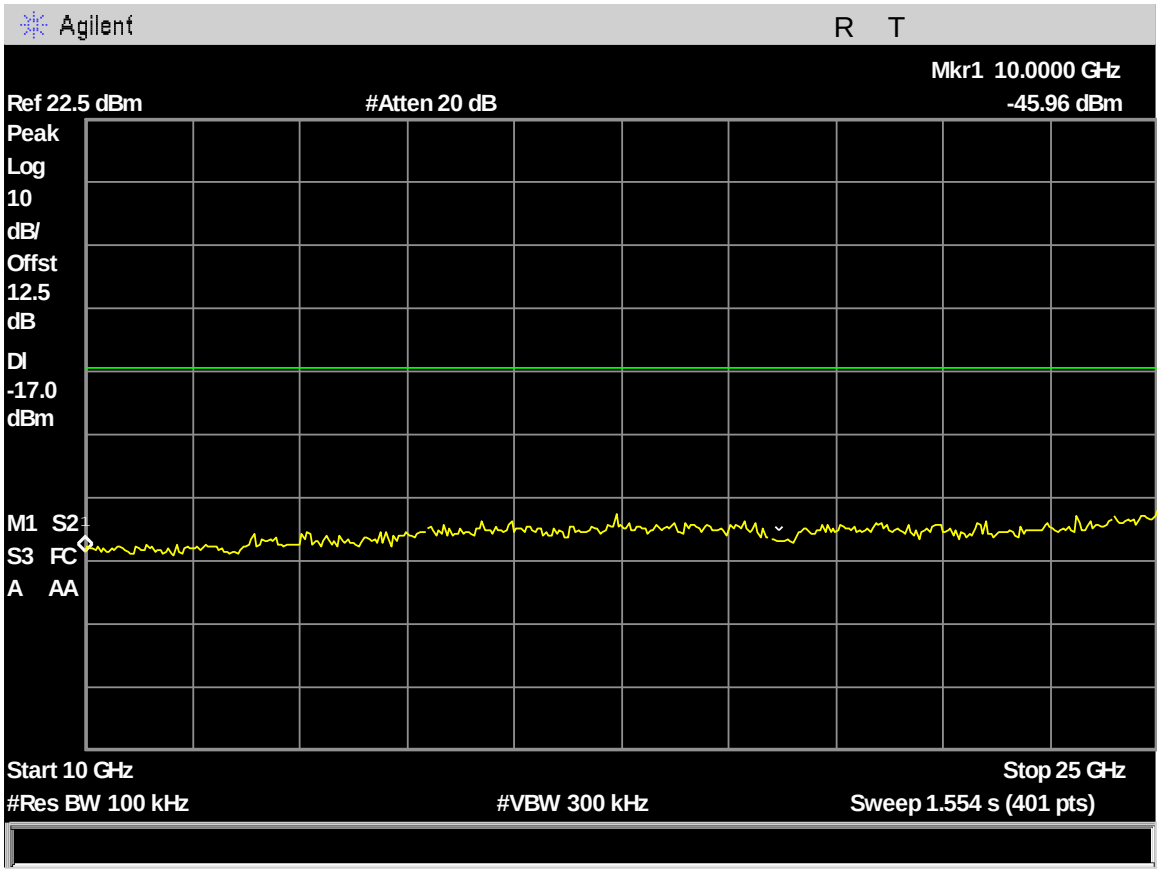

Figure 51: 10 GHz – 25 GHz RF Conducted Spurious Emission Low Channel

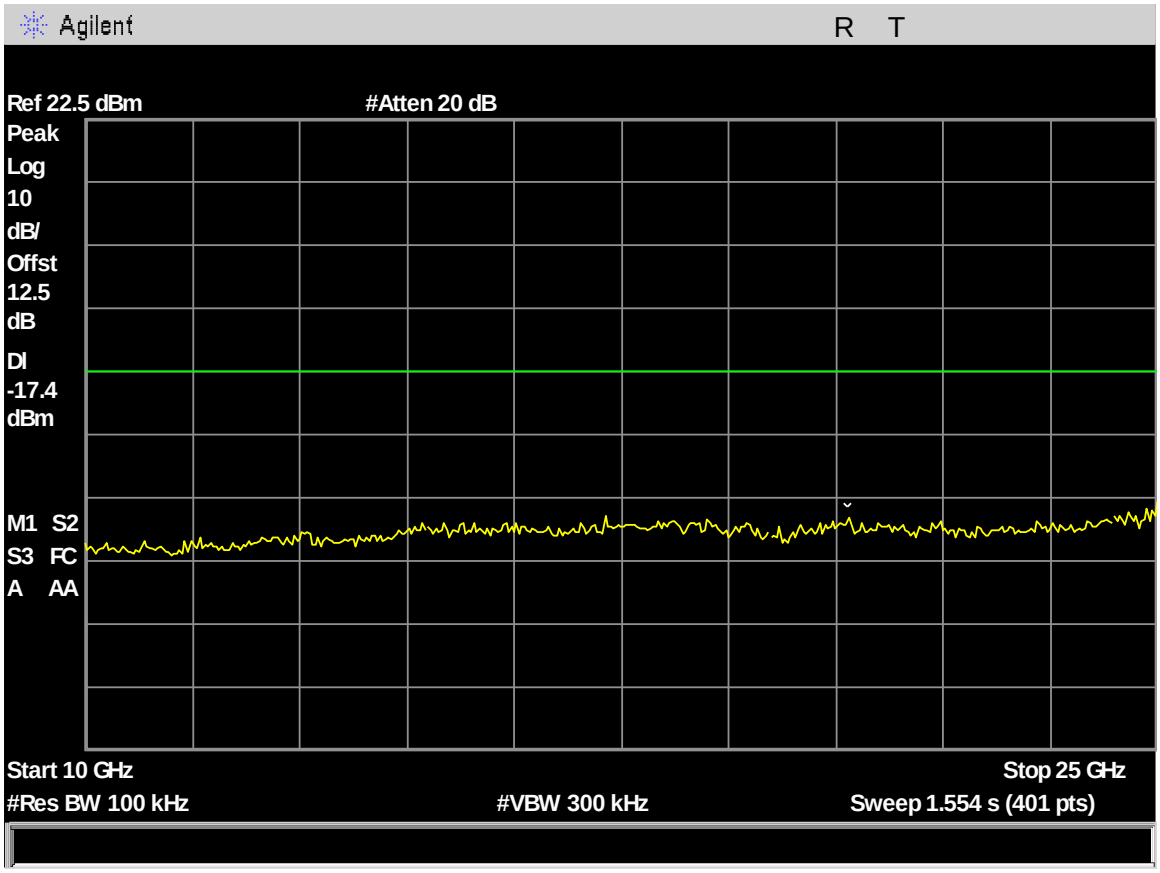

Figure 52: 10 GHz – 25 GHz RF Conducted Spurious Emission Mid Channel

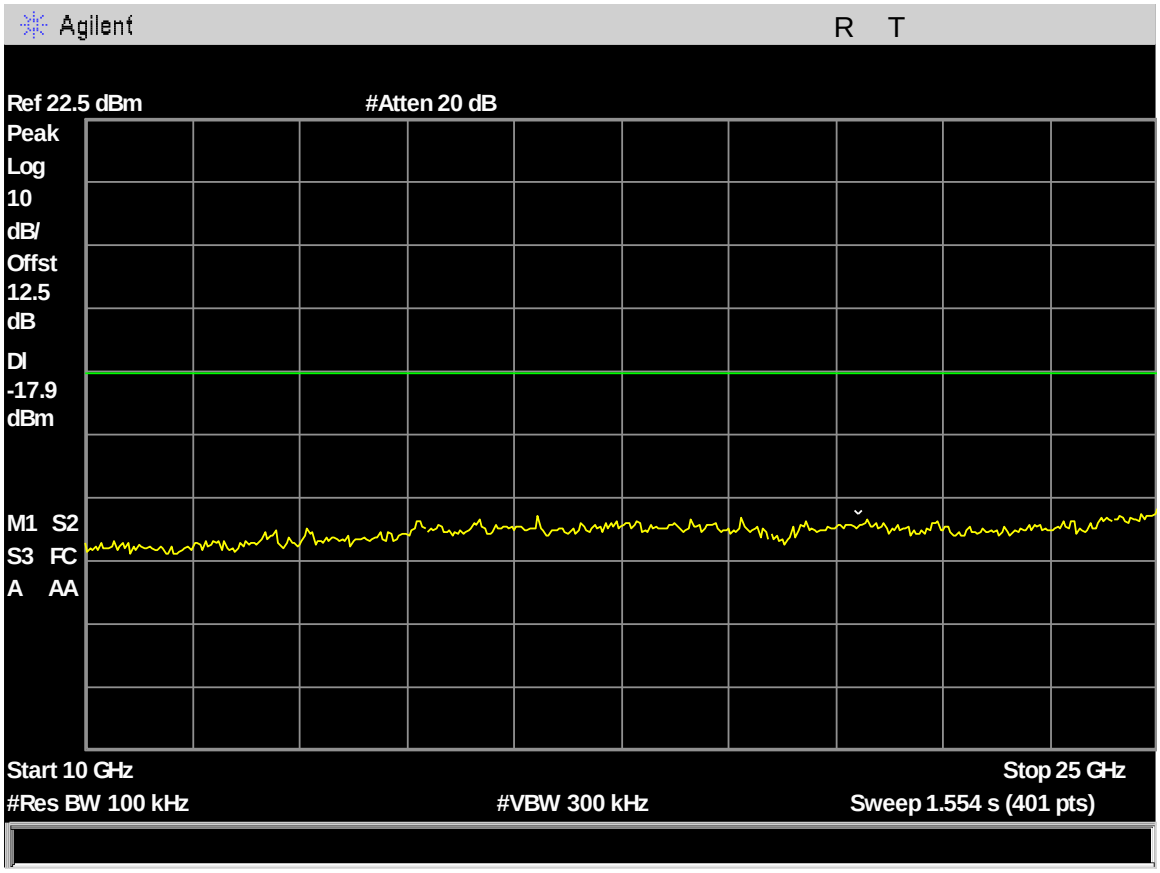

Figure 53: 10 GHz – 25 GHz RF Conducted Spurious Emission High Channel

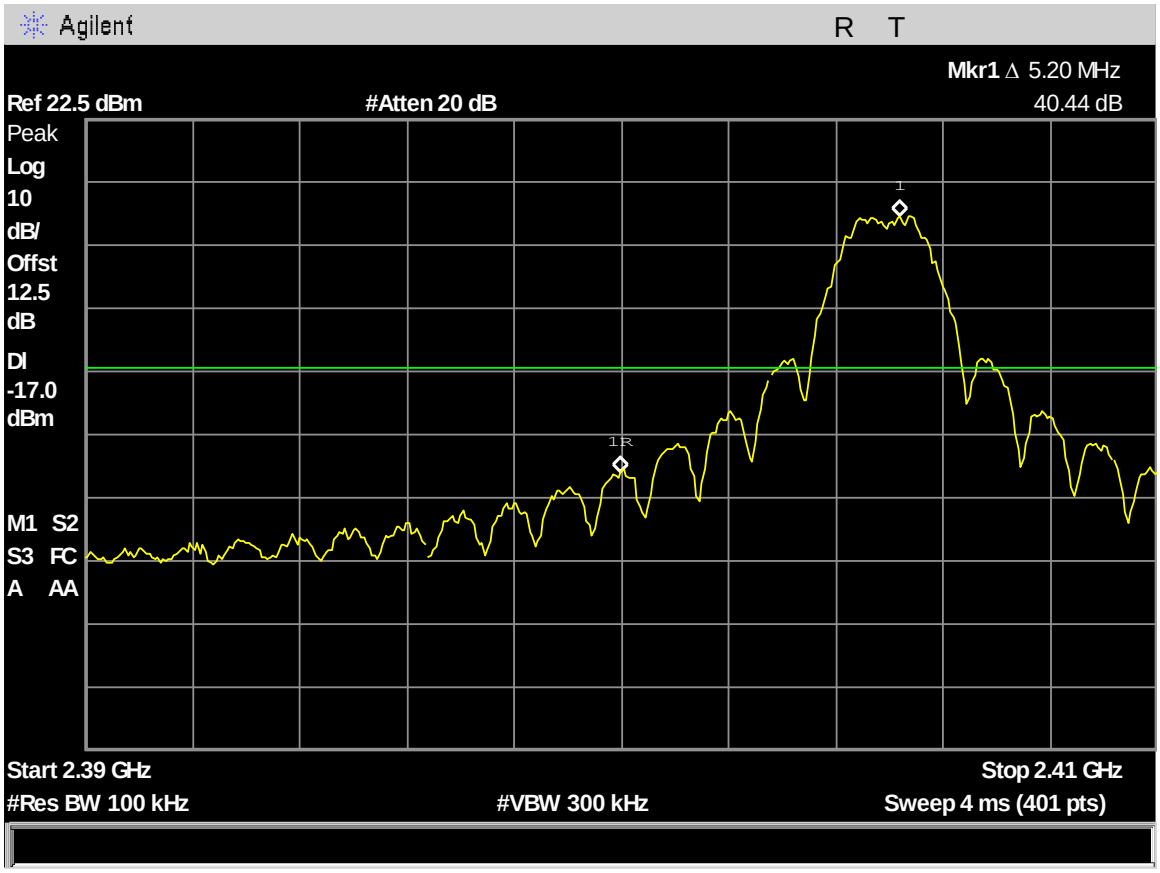

Figure 54: RF Conducted Spurious Emission Low Channel Band Edge

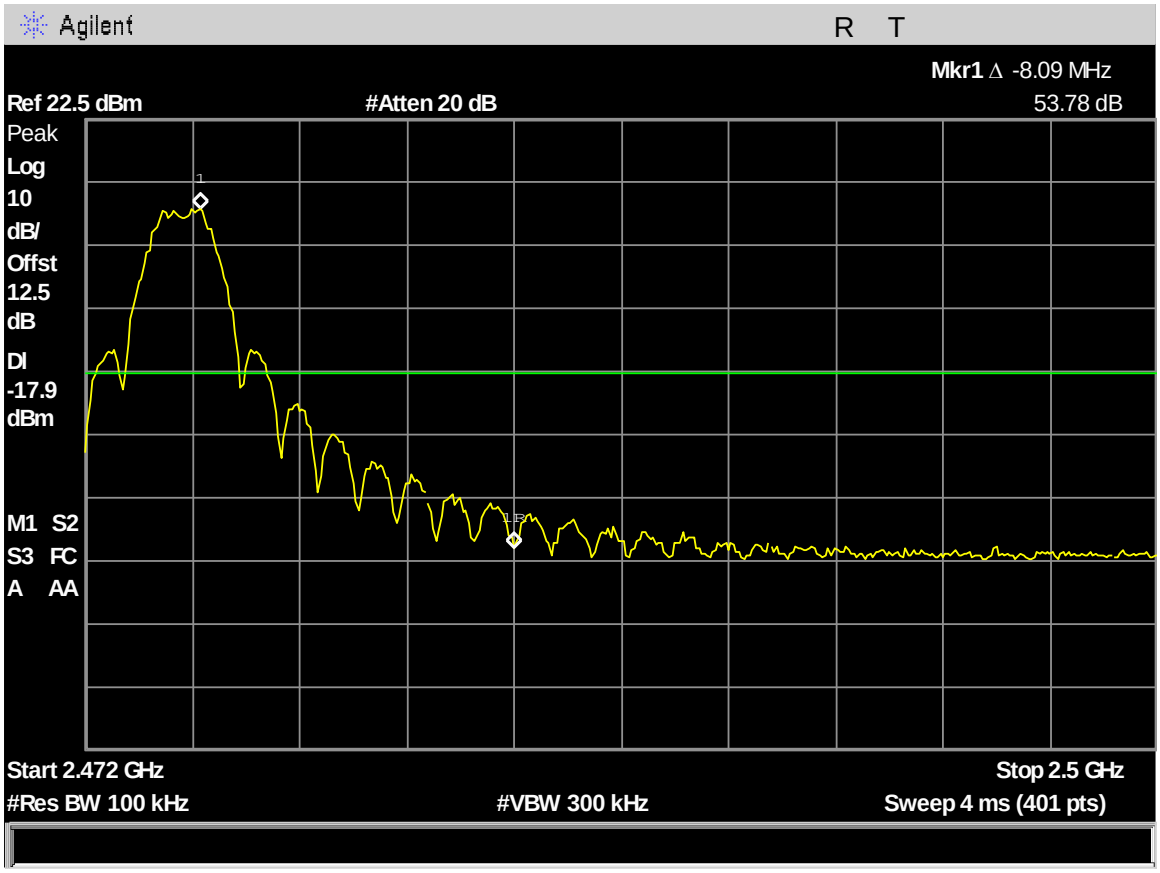

Figure 55: RF Conducted Spurious Emission High Channel Band Edge

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(e) Peak Power Spectral Density

Test Requirements: **§15.247(e):** For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure: The RBW was set to 3 kHz and a VBW set to 9 kHz or greater. The spectrum analyzer was set to an auto sweep time and a peak detector was used. Measurements were carried out at the low, mid and high channels.

Test Results: The EUT was **compliant** with the peak power spectral density limits of **§ 15.247 (e)**.

The peak power spectral density was determined from plots on the following page(s).

Test Engineer: Deepak Giri

Test Date: August 24, 2019

Test Data

Frequency MHz	Power Spectral Density dBm	Antenna Gain dBi	Power Spectral Density Limit dBm
2405	-4.86	1.5	8
2440	-4.837	1.5	8
2475	-4.221	1.5	8

Figure 56: Peak Power Spectral Density, Test Results

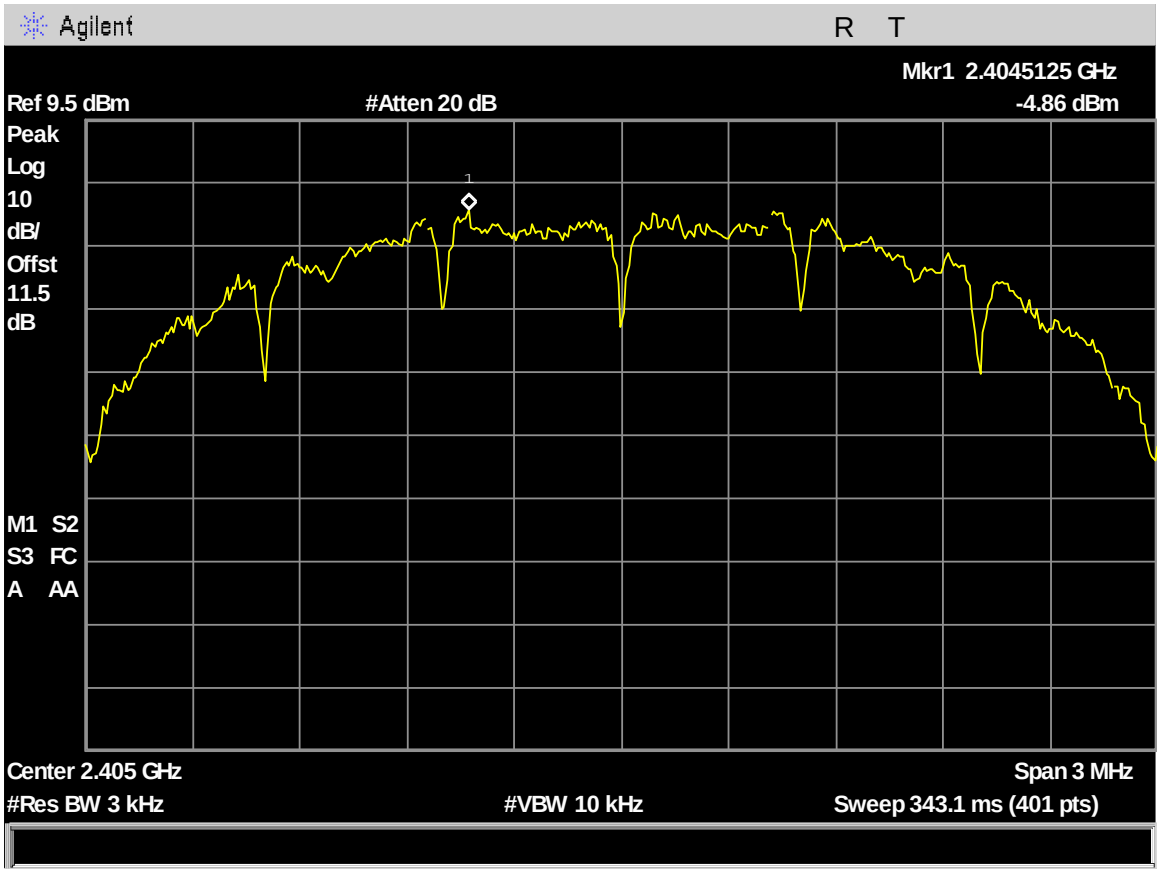

Figure 57: Peak Power Spectral Density Low Channel

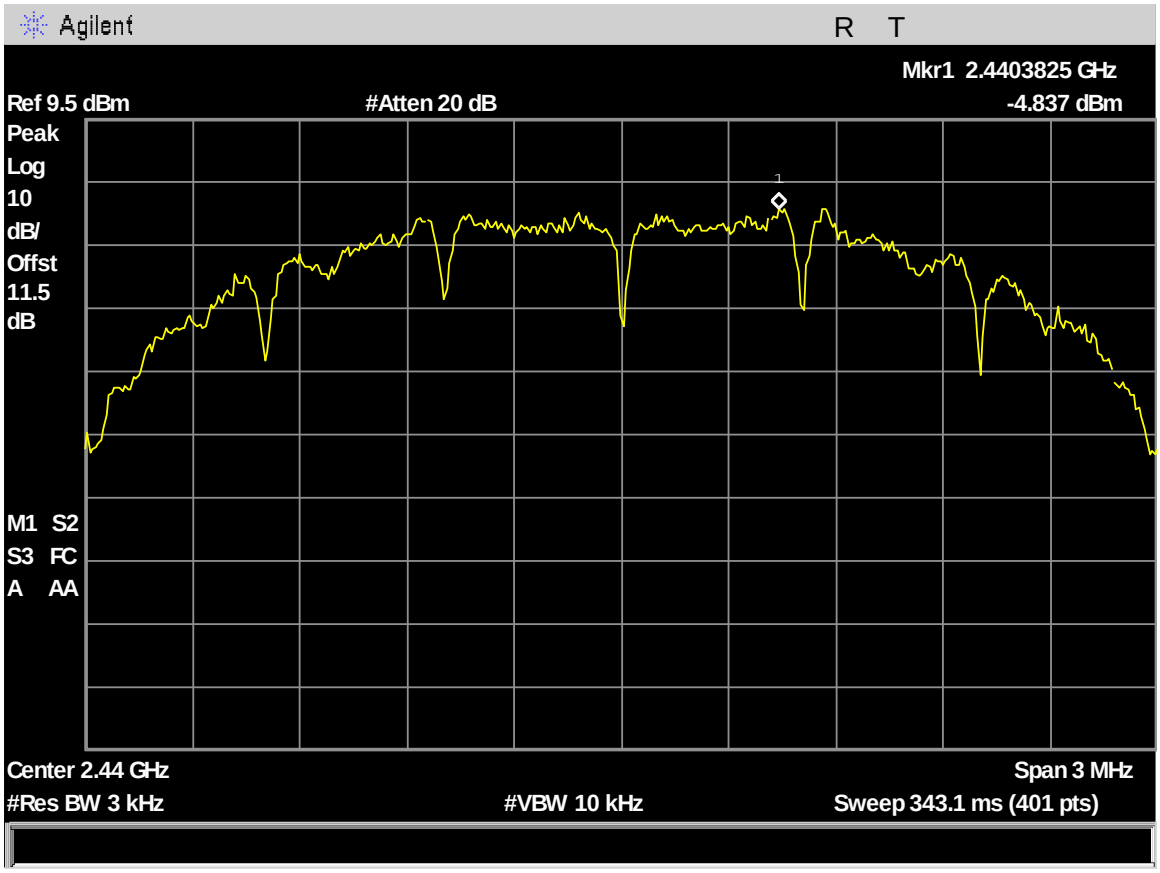

Figure 58: Peak Power Spectral Density Mid Channel

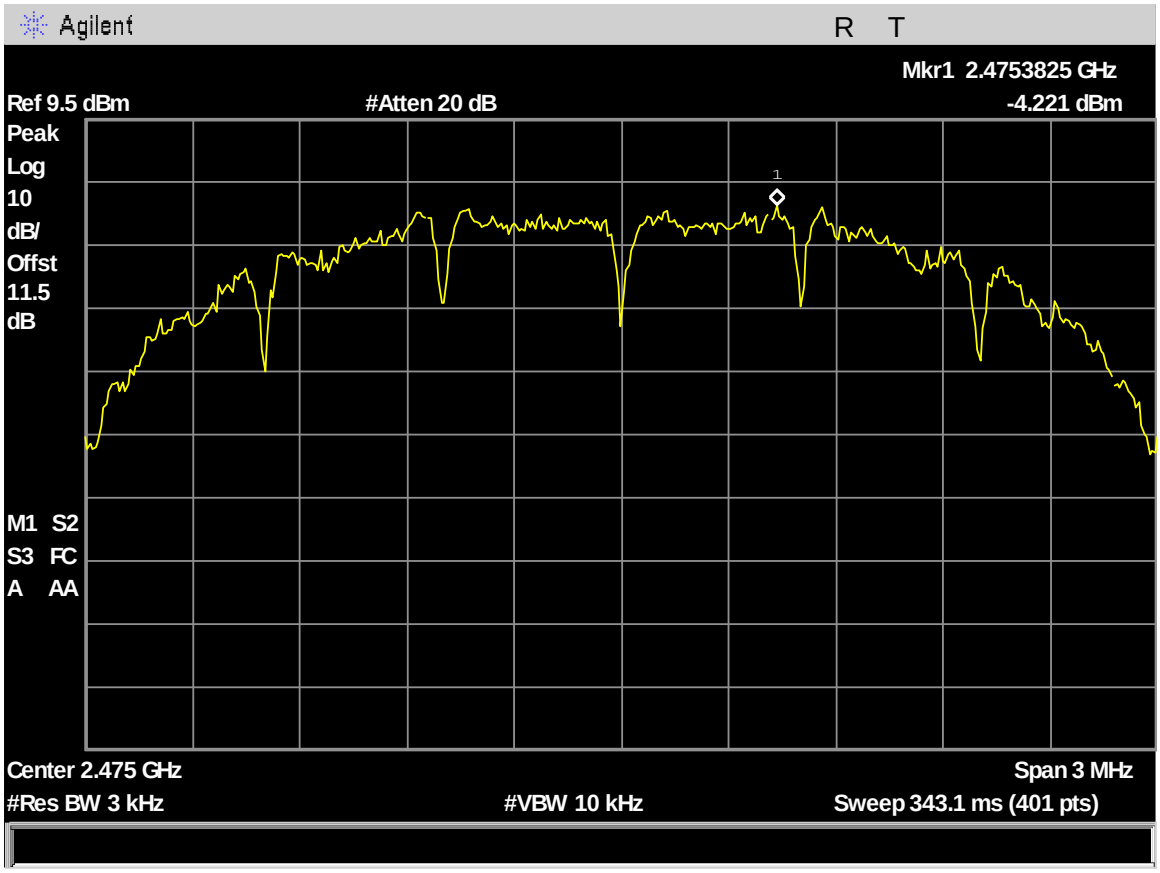

Figure 59: Peak Power Spectral Density High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(i) Maximum Permissible Exposure

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit: EUT's operating frequencies @ 2400-2483.5 MHz; **Limit for Uncontrolled exposure: 1 mW/cm^2 or 10 W/m^2**

Equation from page 18 of OET 65, Edition 97-01

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{(PG / 4\pi S)}$$

where, S = Power Density (mW/cm^2)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

Test Results: The safe distance where Power Density is less than the MPE Limit listed above was found to be 20 cm.

FCC									
Frequency (MHz)	**Con. Pwr. (dBm)**	**Con. Pwr. (mW)**	**Ant. Gain (dBi)**	**Ant. Gain numeric**	**Pwr. Density (mW/cm^2)**	**Limit (mW/cm^2)**	**Margin**	**Distance (cm)**	**Result**
2475	10.61	11.508	1.5	1.413	0.00323	1	0.99677	20	Pass

Figure 60: Maximum Permissible Exposure, RF Exposure FCC

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

MET ASSET #	EQUIPMENT	MANUFACTURER	MODEL	LAST CAL DATE	CAL DUE DATE
1T4149A	HF WIRELESS CHAMBER - NSA			06/30/2019	06/30/2020
1T4905	HORN ANTENNA	COM-POWER	AH-118	05/07/2019	11/07/2020
1T4744	ANTENNA, HORN	ETS-LINDGREN	3116	11/27/2018	11/27/2019
1T4752	PRE-AMPLIFIER	MITEQ	JS44-18004000-35-8P	FUNC VERIFY	FUNC VERIFY
1T8743	PREAMPLIFIER	A.H. SYSTEMS, INC.	PAM-0118P	FUNC VERIFY	FUNC VERIFY
1T4753	ANTENNA - BILOG	SUNOL SCIENCES	JB6	08/30/2018	02/29/2020
1T4300	SEMI-ANECHOIC CHAMBER (NSA)	EMC TEST SYSTEMS	NONE	06/30/2019	06/30/2020
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	01/04/2019	01/04/2021
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	05/16/2018	11/16/2019
1T4612	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	05/15/2018	11/15/2019
1T2947	LISN	SOLAR ELECTRONICS COMPANY	8028-50-TS-24-BNC	08/31/2018	02/29/2020
1T2948	LISN	SOLAR ELECTRONICS COMPANY	8028-50-TS-24-BNC	08/31/2018	02/29/2020

Figure 61: Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

V. Certification & User's Manual Information

Certification & User's Manual Information

A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

End of Report