RADIO TEST REPORT

For

MODEL NO. 1657
FCC ID: C3K1657

Test Report No. R-TR78-FCC-BTLE-2
Issue Date: May 17, 2015

FCC CFR47 Part 15 Subpart C

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	04/01/2015	All	All	First Version	Daniel Salinas
2.0	05/15/2015	9.3, 9.4	20 -27	Updated conducted spurious emissions data	Daniel Salinas

Microsoft

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Test Report Attestation

Microsoft Corporation
Model: 1657
FCC ID: C3K1657

Applicable Standards

Specification	Test Result
FCC CFR47 Rule Parts 15.209, 15.247	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. All indications of Pass/Fail in this report are opinions expressed by the Microsoft EMC Laboratory based on interpretations and/or observations of test result on the tested sample only.

This report shall not be used to claim product certification, approval, or endorsement by A2LA or any agency of any Government. Reproduction, duplication or publication of extracts from this test report is prohibited and requires prior written approval of Microsoft EMC Laboratory.

This test report replaces report # R-TR78-FCCIC-BTLE-1 issued by Microsoft EMC Labs on 04/01/2015.

Written By: Daniel Salinas
Radio Test Engineer

Reviewed/ Issued By: Sajay Jose
EMC/RF Compliance Lab Manager

2 Deviations from Standards

None.

3 Facilities and Accreditations

3.1 Test Facility

All test facilities used to collect the test data are located at
Microsoft EMC Laboratory,
17760 NE 67th Ct,
Redmond WA, 98052, USA

3.2 Accreditations

The lab is established and follows procedures as outlined in IEC/ISO 17025 and A2LA accreditation requirements.
A2LA Accredited Testing Certificate Number: 3472.01
FCC Registration Number: US1141

3.3 Test Equipment

The site and related equipment are constructed in conformance with the requirements of ANSI C63.4:2009, CISPR 16-1-1 and other equivalent applicable standards.
The calibrations of the measuring instruments, including any accessories that may affect such calibration, are checked frequently to assure their accuracy. Adjustments are made and correction factors applied in accordance with instructions contained in the user manual for the measuring equipment.

4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the product, as specified in CISPR 16-4-2. This represents an expanded uncertainty expressed at 95% confidence level using a coverage factor k=2. These numbers are for reference only and not applied during test.
Expanded uncertainty calculations are available upon request.

Test item	Value (dB)
Radiated disturbance (30 MHz to 1 GHz)	6.10
Radiated disturbance (1 GHz to 18 GHz)	4.80
Conducted Disturbance at Mains Port	3.30

5 Product Description

Company Name:	Microsoft Corporation
Address:	One Microsoft Way
City, State, Zip:	Redmond, WA 98052-6399
Customer Contact:	Sahithi Kandula
Functional Description of the EUT:	Handheld computing device with 802.11 2x2 a/b/g/n/ac WLAN, Bluetooth, WCDMA and LTE Radios
Model:	1657
FCC ID:	C3K1657
Radio Description:	BT LE (2402- 2480 MHz)
Modulation:	GFSK
Antenna Type and Gain:	Internal 3.6 dBi
EUT Classification:	DTS
Equipment Design State:	DV/Production
Equipment Condition:	Good
Test Sample Details:	SN: 000106745252- Conducted SN: 001364745052 - Radiated

5.1 Test Configurations

Test software “WiFi Tool” (V2.6.0) created by the customer and “Lab Tool” (V2.0.0.57) by the module vendor was used to program the EUT to transmit continuously in GFSK mode. Channel numbers 0, 19 and 39 are used as the Low/Mid/High channels of test.

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.

6 Test Results Summary

Test Description	FCC CFR 47	Limit	Test Result
6dB Bandwidth	15.247 (a)(2)	> 500kHz	Pass
Output Power	15.247 (b)(3)	< 1 Watt	Pass
Power Spectral Density	15.247 (e)	< 8dBm/3kHz	Pass
Conducted Band Edge/Spurious Emissions	15.247 (d)	< 20dBc	Pass
Radiated Spurious Emissions/ Restricted Band Emissions	15.205, 15.209	FCC CFR 47 15.209 limits	Pass
AC Power line Conducted Emissions	15.207	FCC CFR 47 15.207 limits	Pass

7 Test Equipment List

The site and related equipment are in conformance with the requirements of ANSI C63.4:2009, CISPR 16-1-1, and other equivalent applicable standards.

Manufacturer	Description	Model #	Asset #	Calibration Due
Agilent Technologies	Spectrum Analyzer	N9030A	EMC-061	02/04/2016
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-012	4/27/2015
Rhode & Schwarz	Spectrum Analyzer	FSV 40	RF-245	11/03/2015
Rohde & Schwarz	Switch Control Unit	OSP130	RF-018	5/16/2015
Rohde & Schwarz	Switch Control Unit	OSP150	RF-019	5/16/2015
Rohde & Schwarz	Signal Generator	SMB 100A	RF-013	9/04/2015
Micro-Tronix	Notch Filter	BRM50702-02	RF-055	N/A*
Sunol Sciences	Antenna	JB6	RF-039	5/05/2015
ETS-Lindgren	Antenna	3117	RF-139	7/10/2015
ETS-Lindgren	Antenna	3160-09	RF-037	N/A (Std Gain Horn)
Rohde & Schwarz	Pre-Amp	TS-PR18	RF-041	N/A*
Rohde & Schwarz	Pre-Amp	TS-PR26	RF-042	N/A*
Rosenburger	RF Cable	L72-449-915	EMC-326	N/A*
Madgetech	THP Monitor	PRHTemp2000	EMC-677	10/31/2015
Rohde & Schwarz	Software	EMC-32 V9.15	N/A	N/A

*Note: List of equipment that fall under the category of cables, pre-amplifiers or switching panels with Calibration due date of “n/a” have regular in house verification.

The calibrations of the measuring instruments, including any accessories that may affect such calibration, are checked frequently to ensure their accuracy.

8 Test Site Description

8.1 Radiated Emissions Test Site

Radiated measurements are performed in a 3m semi-anechoic chamber, which fully meets NSA requirements for the frequency range of 30MHz to 1000MHz and SVSWR for 1-18GHz.

An Antenna mast and Turntable are used for changing Antenna height and EUT azimuth respectively. For all measurements, the Antenna height is varied from 1 meter to 4 meters and the turn table rotated 360 degrees to determine the highest emissions. A non-conducting 1m x 1.5m x 80cm table is installed on the turntable to support the EUT.

The EUT and its support equipment were exercised and cabling manipulated to maximize each emission.

For radiated emissions above 1GHz, linearly polarized horn antennas are used. RF absorbers cover the ground plane such that the site validation criterion called out in CISPR 16-1-4 is met. For radiated measurements below 1GHz, Linearly polarized broadband antennas are used. The RF absorbers are removed to reveal the ground plane.

8.2 Antenna port conducted measurements

All antenna port conducted measurements are 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 is added internally in the Analyzer settings. The plots displayed accounts for these correction factors.

8.3 Test Setup Diagrams

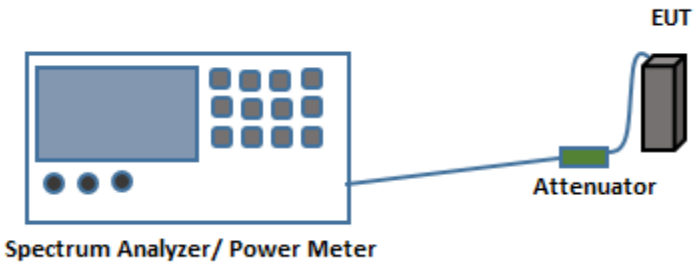


Fig.1. Test Setup for Antenna port conducted measurements

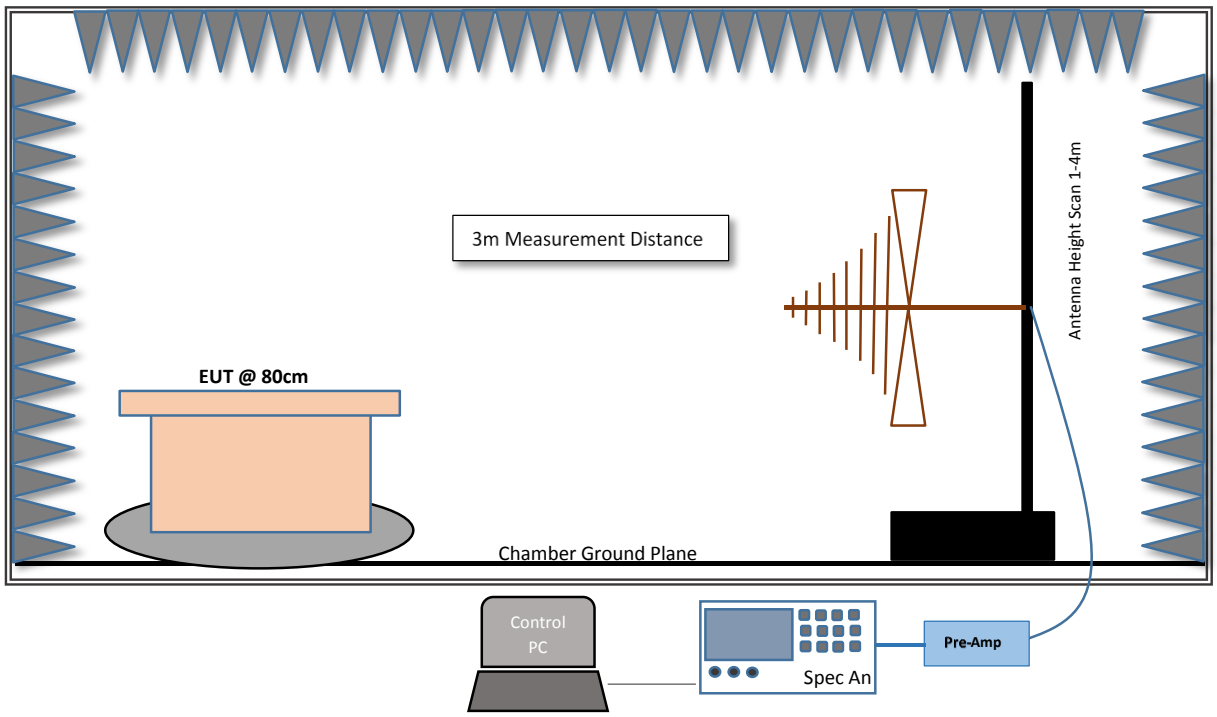


Fig.2. Test Setup for Radiated measurements in 30MHz- 1GHz Range

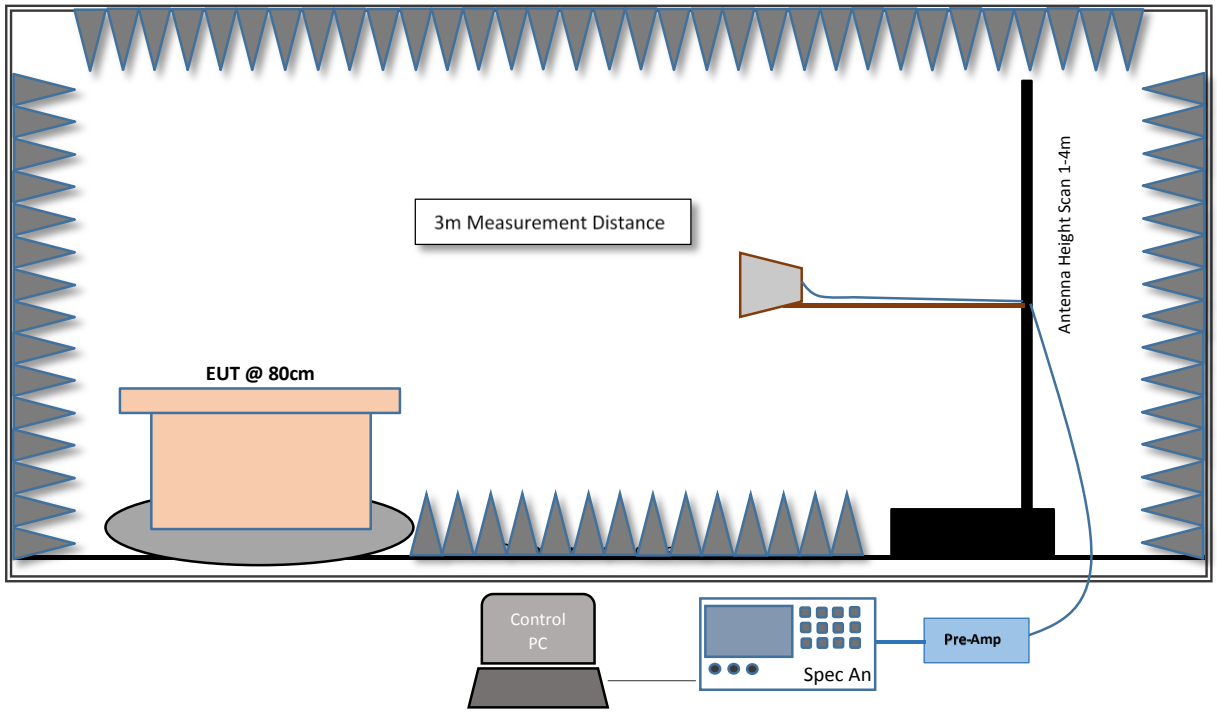


Fig.3. Test Setup for Radiated measurements in 1GHz- 18GHz Range

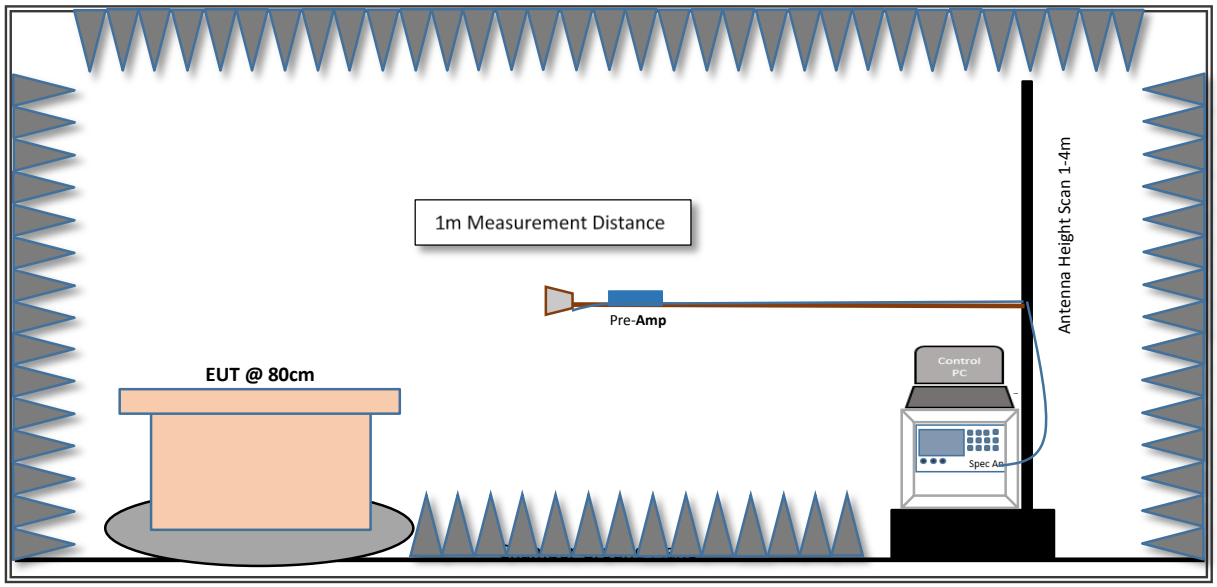


Fig.4. Test Setup for Radiated measurements >18GHz

9 Test Results- Conducted

9.1 6-dB Bandwidth

9.1.1 Test Requirement:

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

9.1.2 Test Method:

Measurements are performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R02.

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

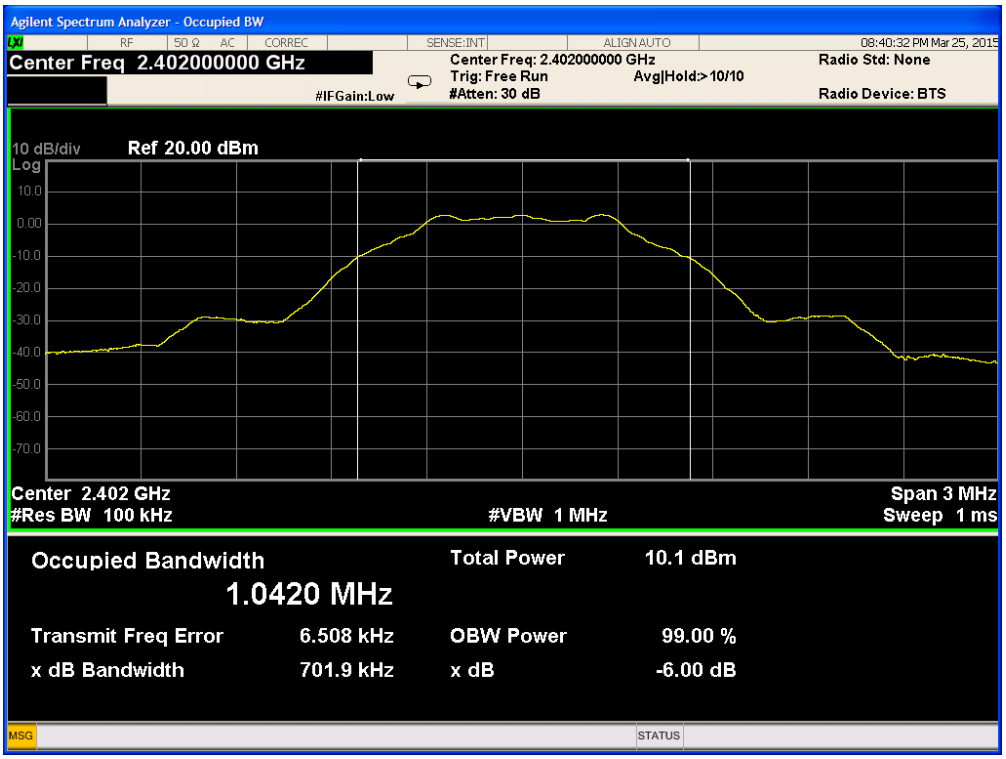
9.1.3 Limits:

The 6-dB bandwidth shall be at least 500 kHz

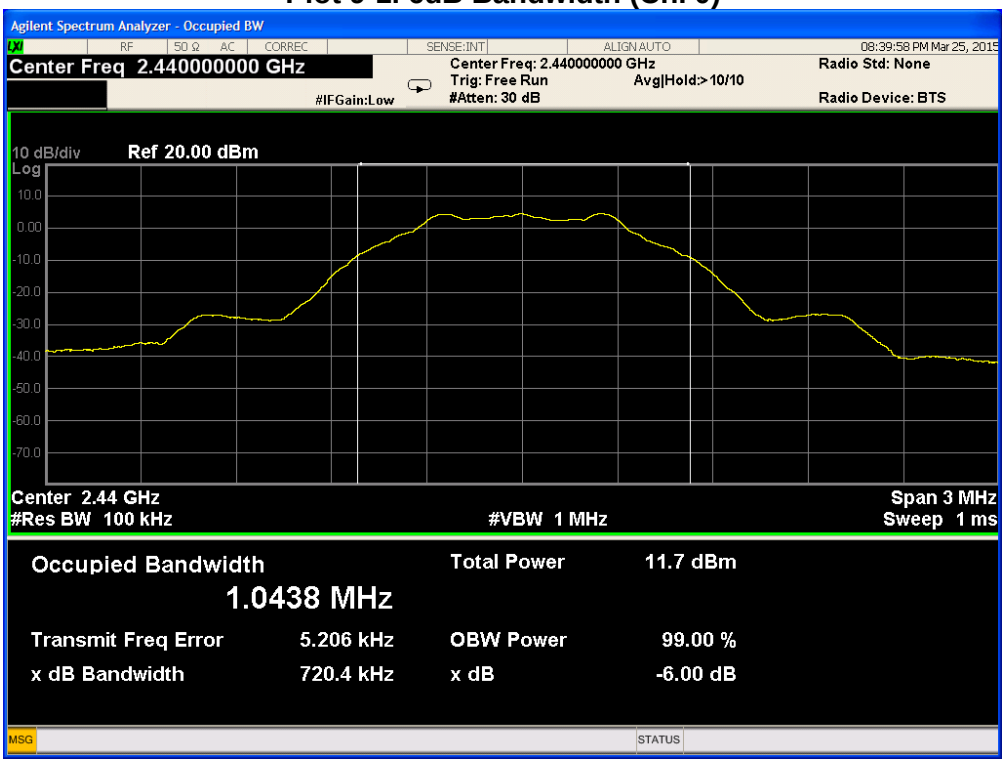
9.1.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	6dB Bandwidth (kHz)	Limit (kHz)	Result
2402	BT LE	0	701.9	500	PASS
2440	BT LE	19	720.4	500	PASS
2480	BT LE	39	718.1	500	PASS

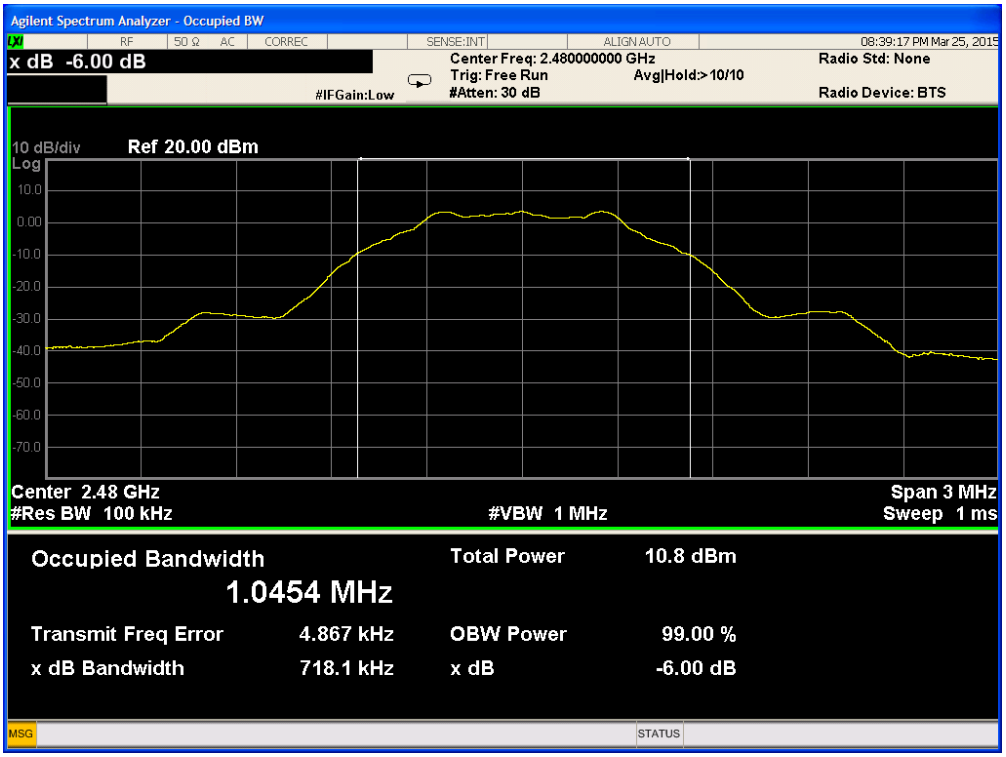
9.1.5 Test Data:



Plot 9-1. 6dB Bandwidth (Ch. 0)



Plot 9-2. 6dB Bandwidth (Ch. 19)



Plot 9-3. 6dB Bandwidth (Ch. 39)

9.2 Output Power

9.2.1 Test Requirement:

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

9.2.2 Test Method:

Measurements are performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R02.

Spectrum Analyzer settings:

Peak Power:

RBW= 1 MHz
VBW= 3 MHz
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto
Span= 5 MHz

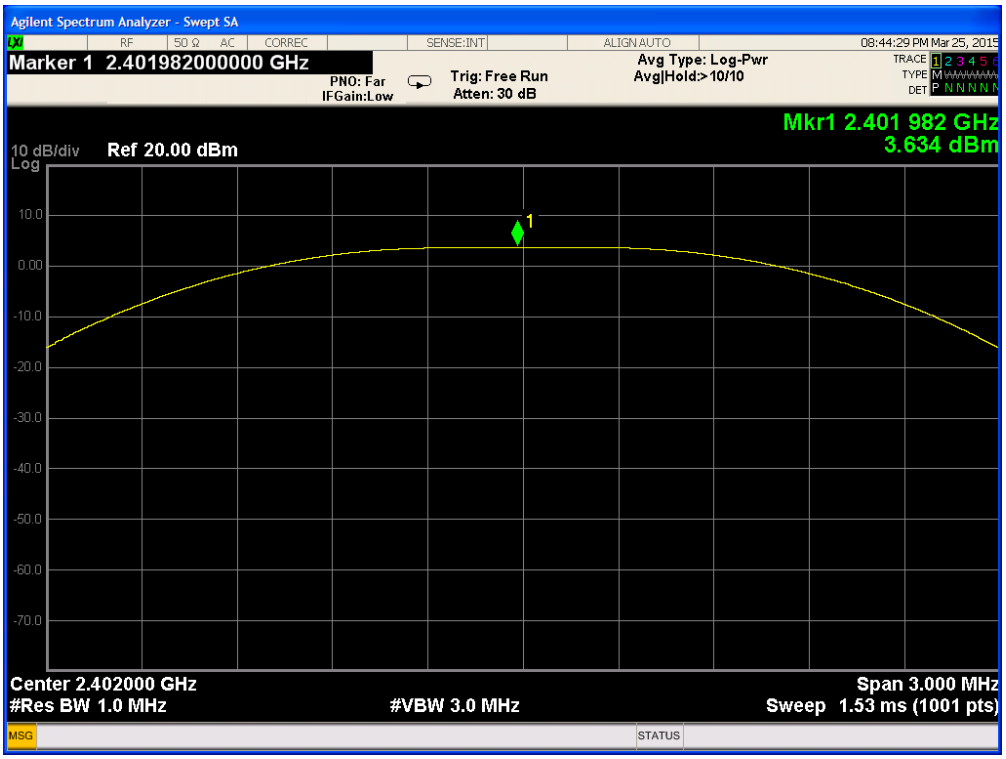
9.2.3 Limits:

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

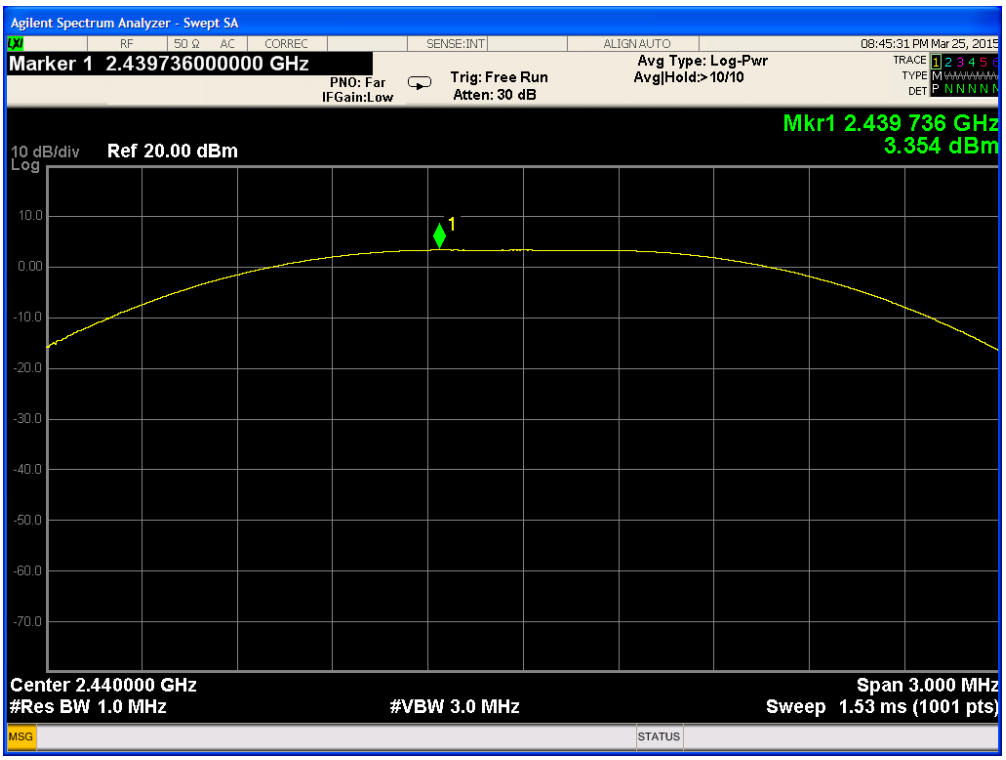
9.2.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	Peak Power (dBm)	Peak Power (W)	Result
2402	BT LE	0	3.634	0.002	PASS
2440	BT LE	19	3.354	0.002	PASS
2480	BT LE	39	3.324	0.002	PASS

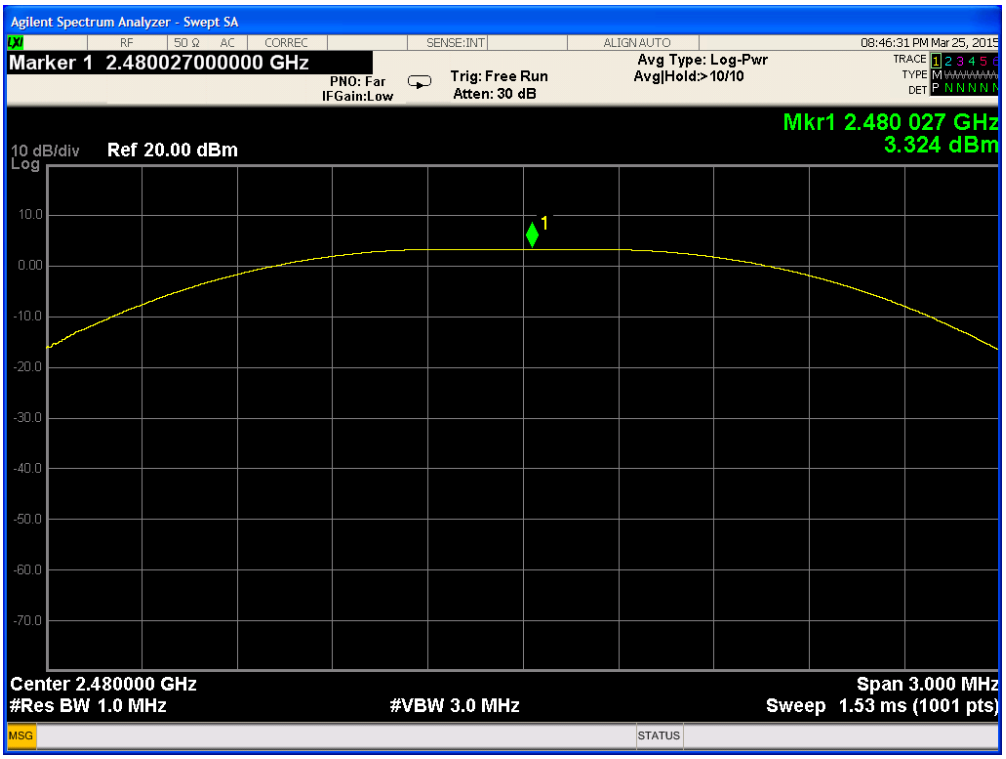
9.2.5 Test Data:



Plot 9-4. Peak Power (Ch. 0)



Plot 9-5. Peak Power (Ch. 19)



Plot 9-6. Peak Power (Ch. 39)

9.3 Peak Power Density

9.3.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (e)

9.3.2 Test Method:

Measurements are performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R02.

Spectrum Analyzer settings:
RBW= 100 kHz (Reduced to 3 kHz if necessary)
VBW= 1 MHz
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto

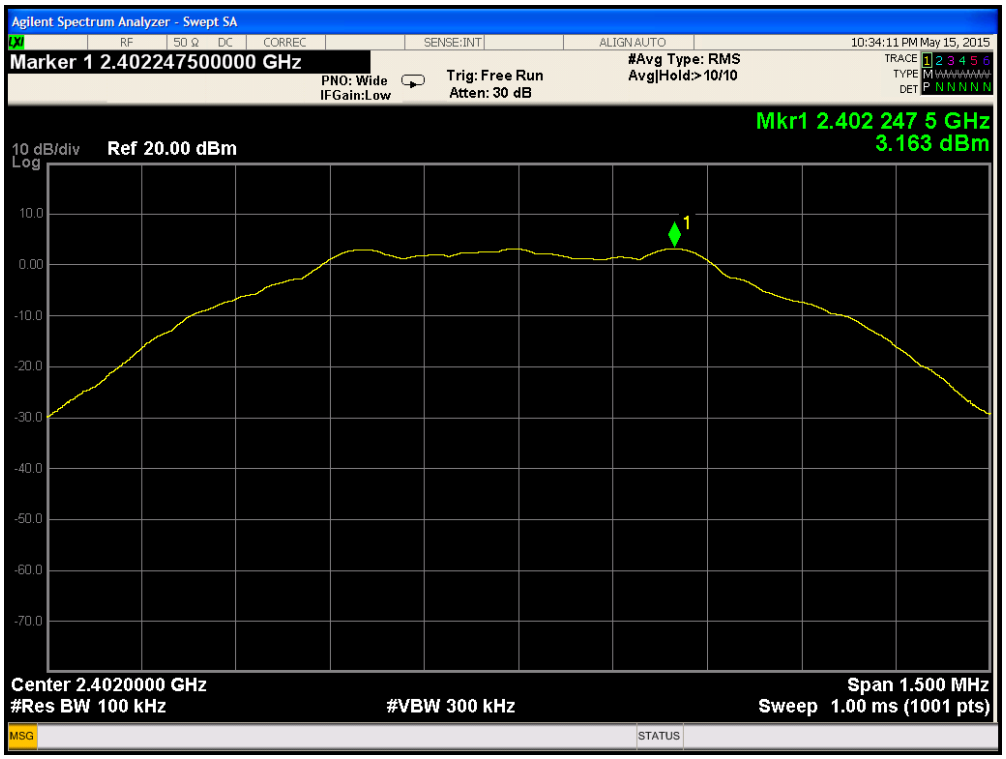
9.3.3 Limits:

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

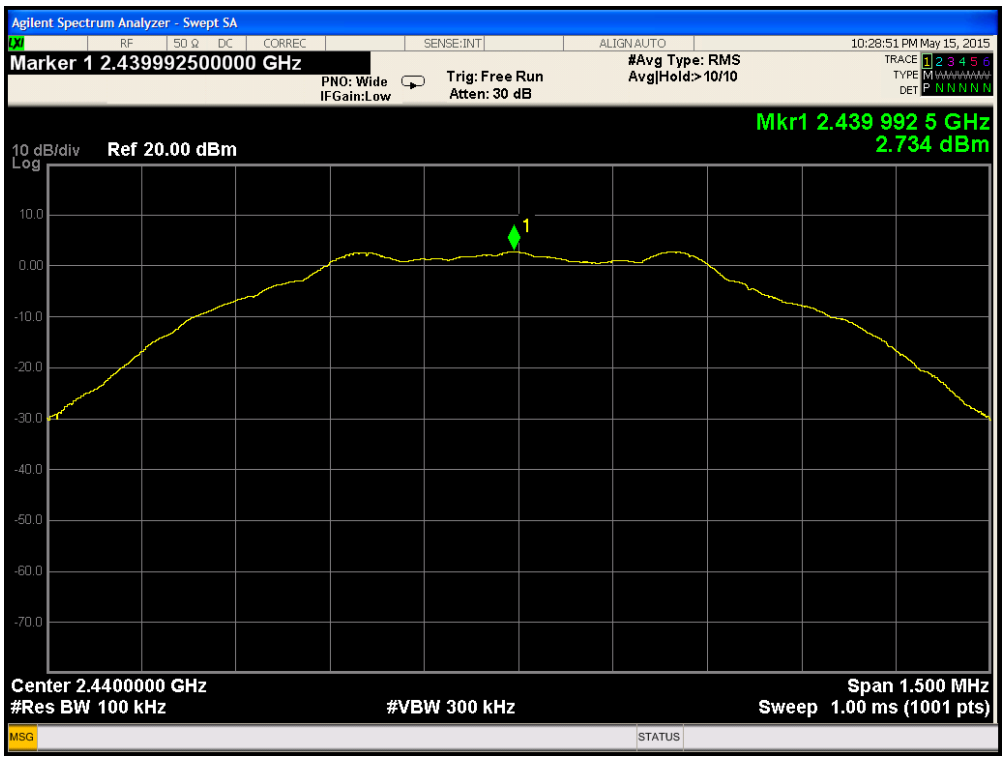
9.3.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	Power Spectral Density (dBm/100kHz)	Limit (dBm/3kHz)	Result
2402	BT LE	0	3.063	8	PASS
2440	BT LE	19	2.752	8	PASS
2480	BT LE	39	3.284	8	PASS

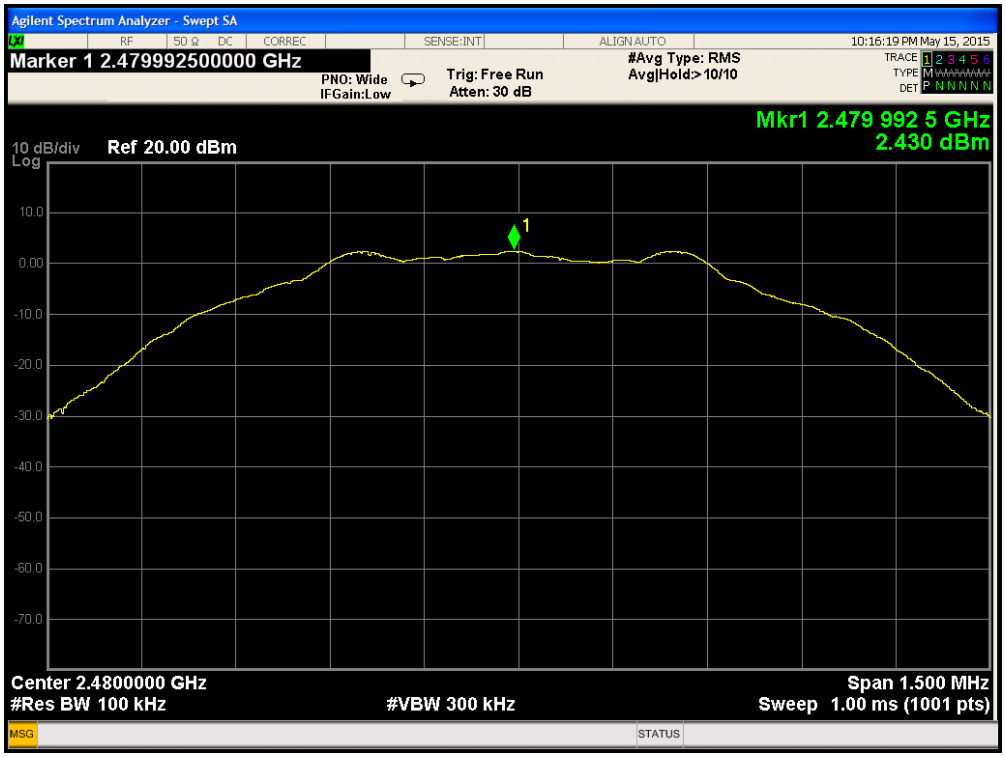
9.3.5 Test Data:



Plot 9-7. Power Spectral Density (Ch. 0)



Plot 9-8. Power Spectral Density (Ch. 19)



Plot 9-9. Power Spectral Density (Ch. 39)

9.4 Conducted Spurious Emissions

9.4.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

9.4.2 Test Method:

Measurements are performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R02.

Spectrum Analyzer settings:

Identification of Reference Level:

RBW= 100 kHz
VBW ≥ 3 x RBW
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto
Span= 5 MHz
Peak Marker function to determine the max PSD level.

Conducted Spurious Emissions:

A higher RBW setting was used for the measurements due to the limitation in number of sweep points on the Spectrum Analyzer.
RBW= 1 MHz
VBW≥ 3 x RBW
Trace Mode= Peak Detector (Max Hold)
Sweep time= Auto
Span= 30 MHz- 12 GHz and 12 GHz- 25 GHz.

9.4.3 Limits:

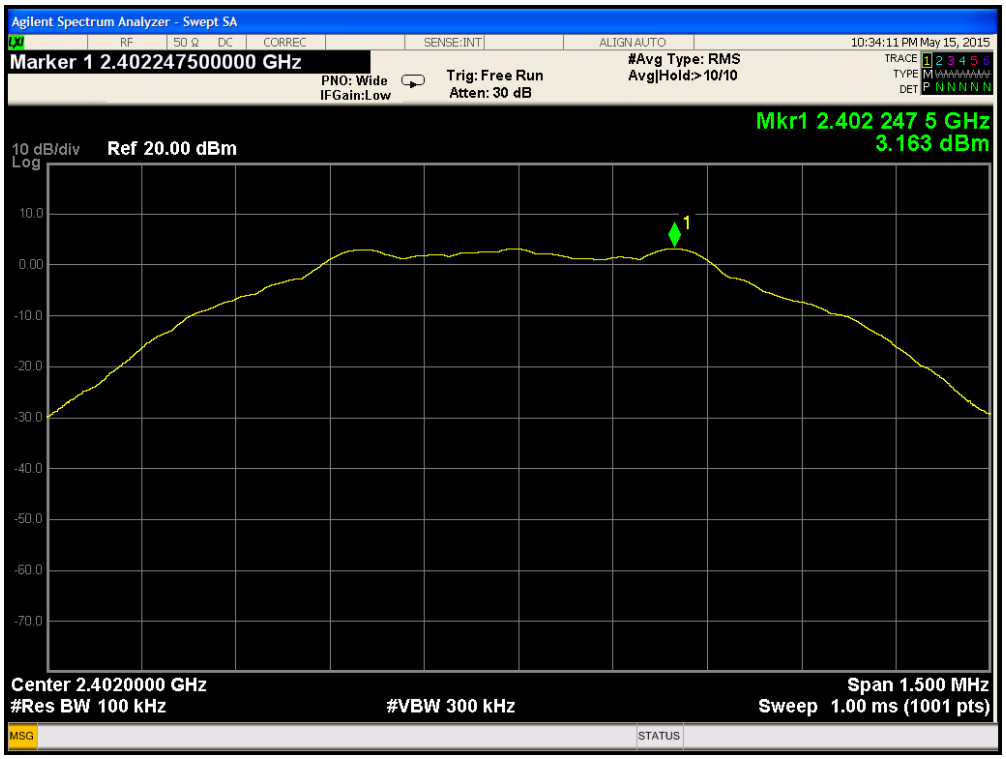
All spurious emissions >20 dBc.

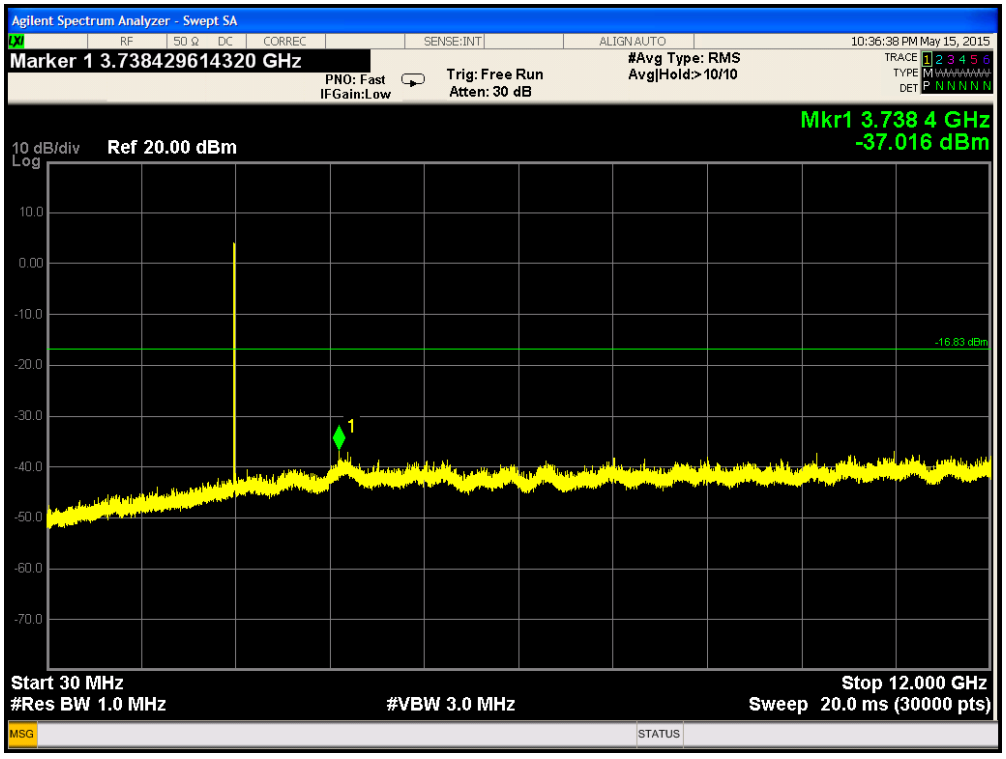
9.4.4 Test Result:

Pass.

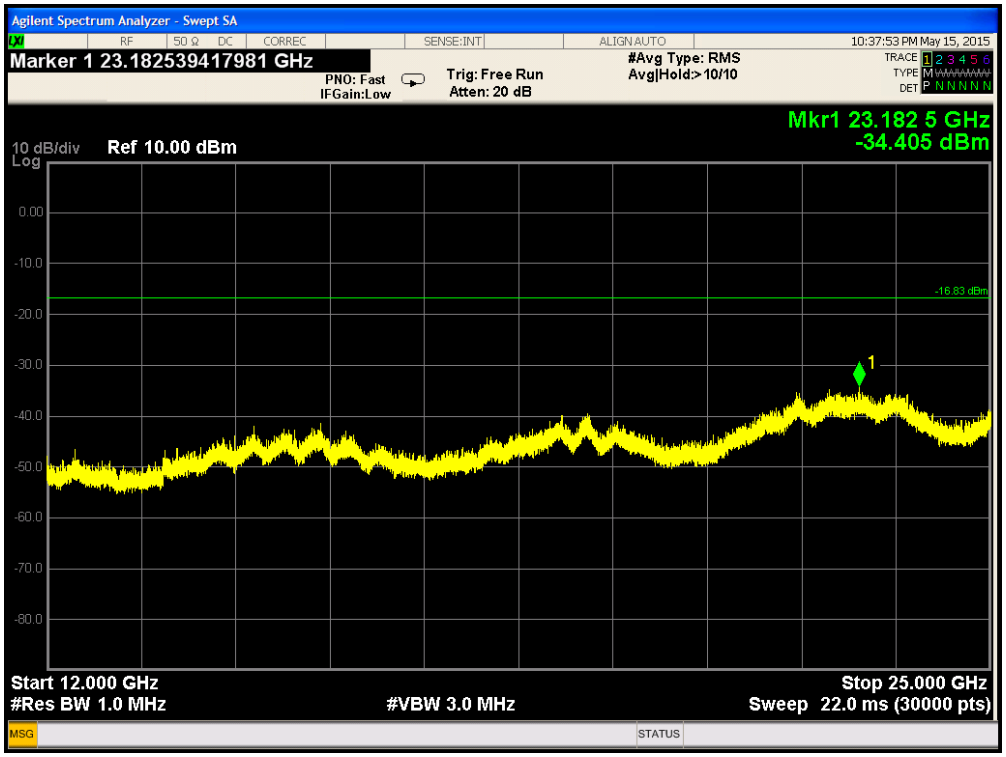
All spurious emissions below the limit at 1MHz RBW setting.

9.4.5 Test Data:

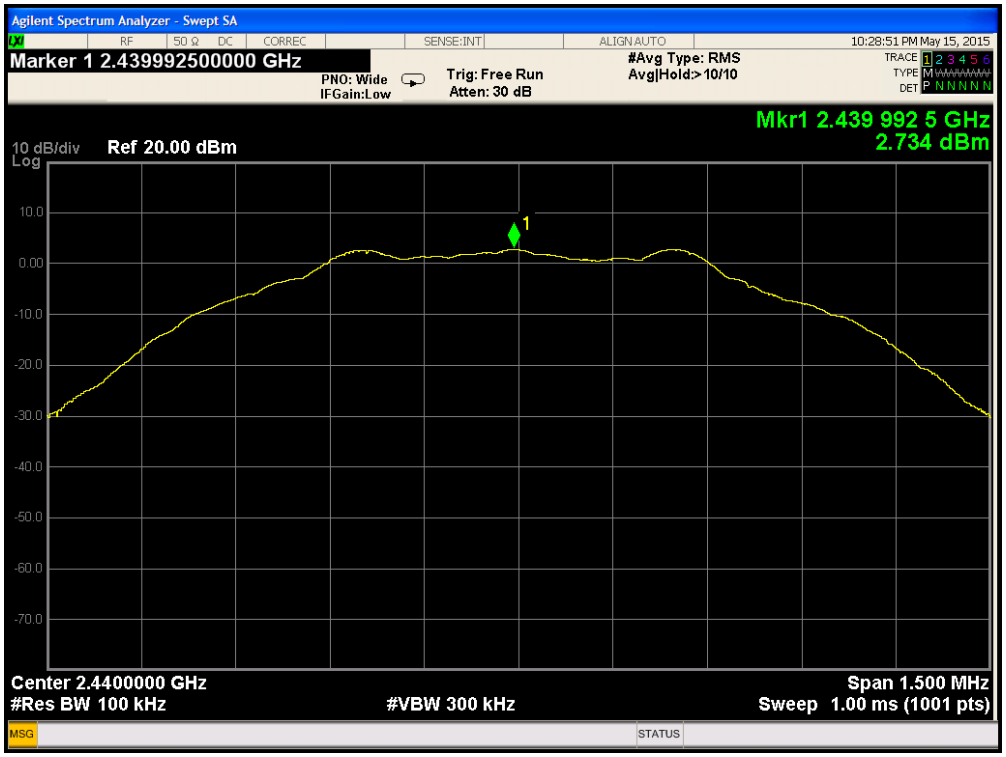


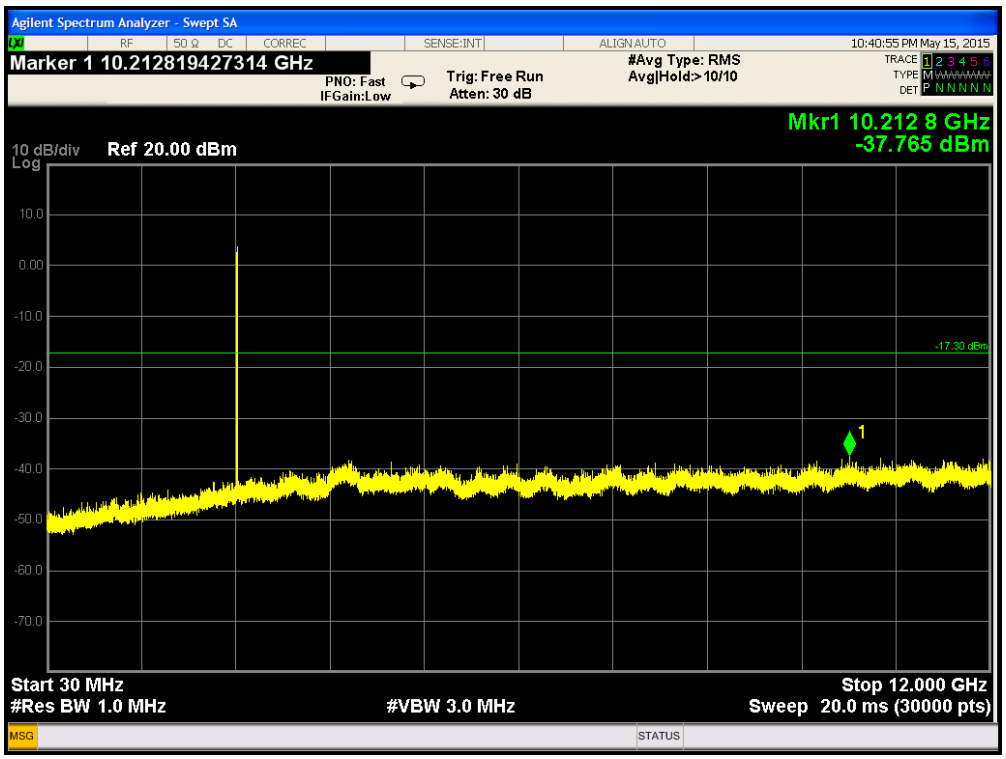


Plot 9-10. Conducted Spurious Emissions 30 MHz – 12 GHz (Ch. 0)

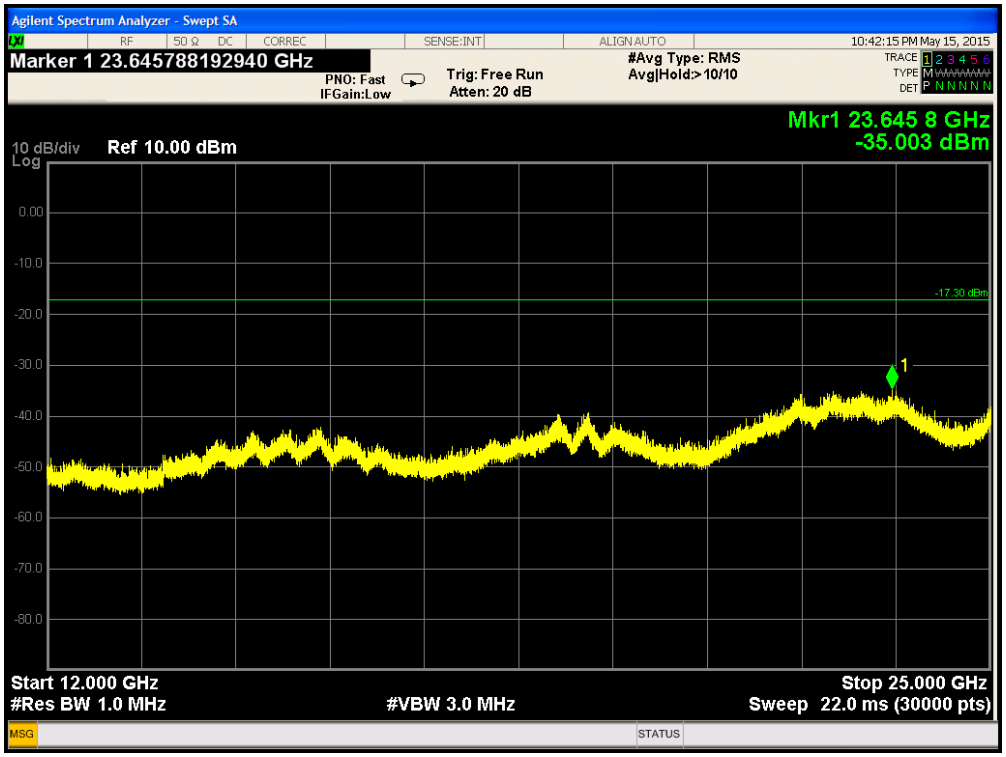


Plot 9-11. Conducted Spurious Emissions 12 - 25 GHz (Ch. 0)

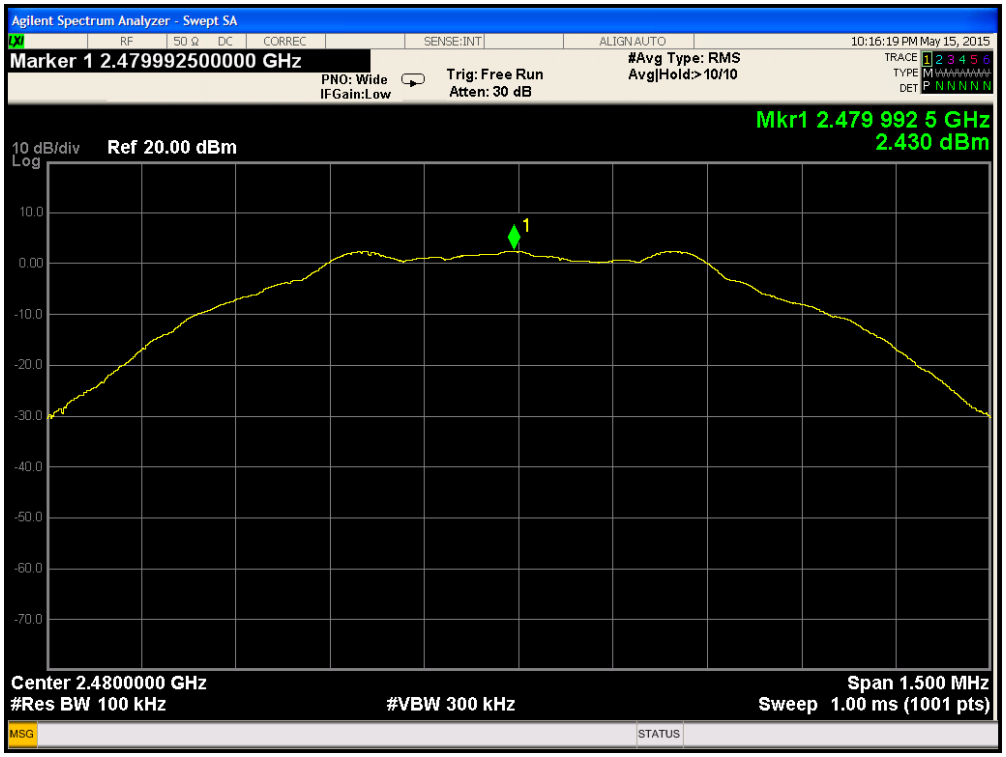


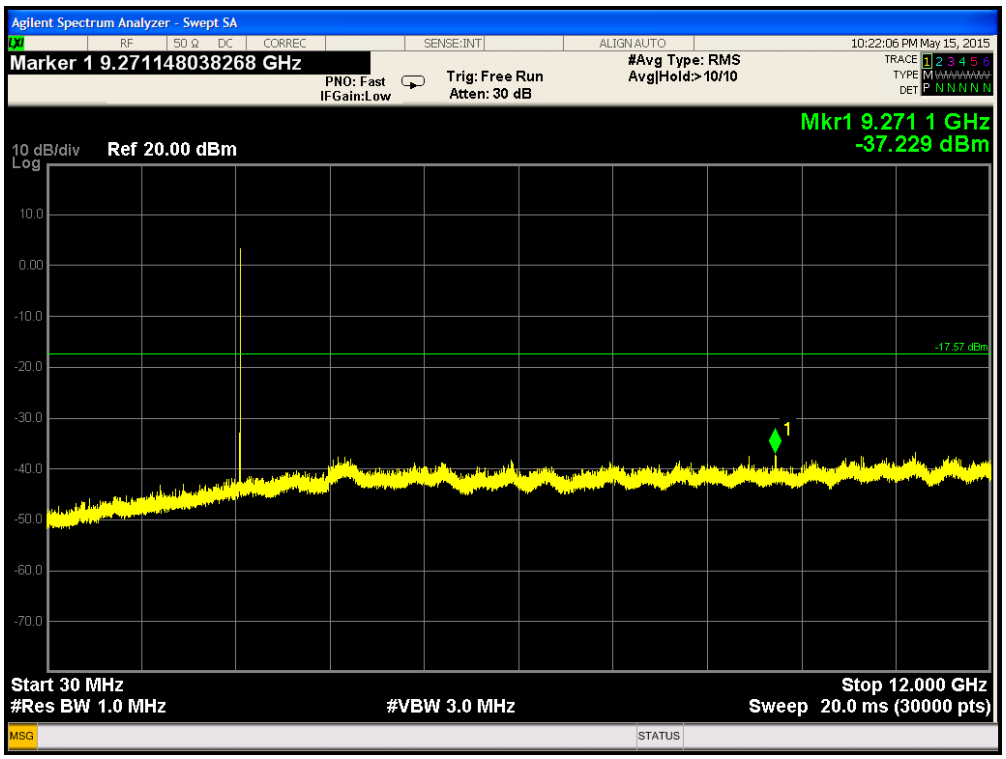


Plot 9-12. Conducted Spurious Emissions 30 MHz – 12 GHz (Ch. 19)

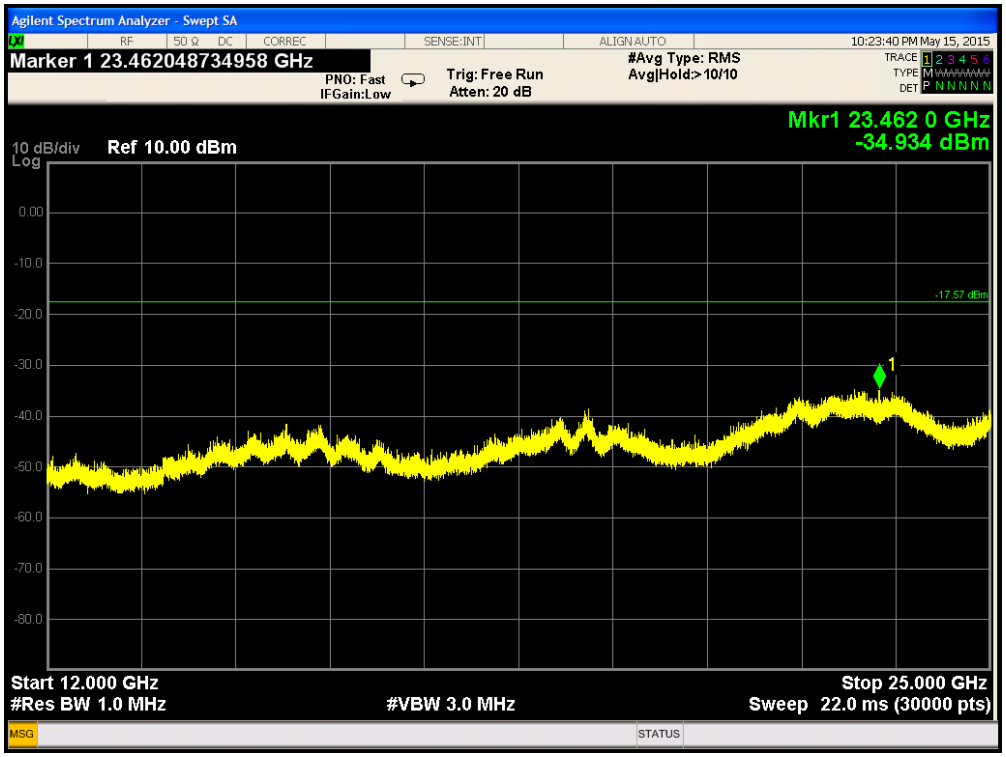


Plot 9-13. Conducted Spurious Emissions 12 - 25 GHz (Ch. 19)





Plot 9-14. Conducted Spurious Emissions 30 MHz – 12 GHz (Ch. 39)



Plot 9-15. Conducted Spurious Emissions 12 – 25 GHz (Ch. 39)

9.5 Conducted Band Edge Emissions

9.5.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

9.5.2 Test Method:

Measurements are performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R02. A spectrum analyzer with pre-selection was used.

Spectrum Analyzer settings:

Band Edge Emissions:

RBW= 100 kHz
VBW ≥ 3 x RBW
Detector= Peak
Sweep time= Auto
Trace= Max Hold

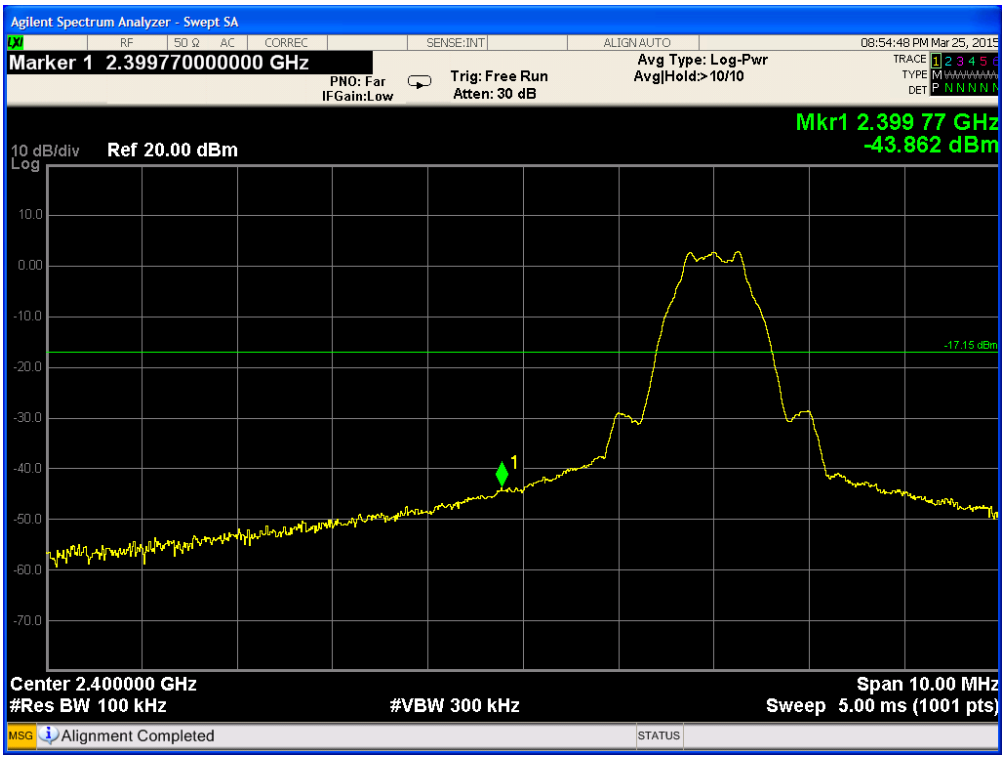
9.5.3 Limits:

All spurious emissions >20 dBc.

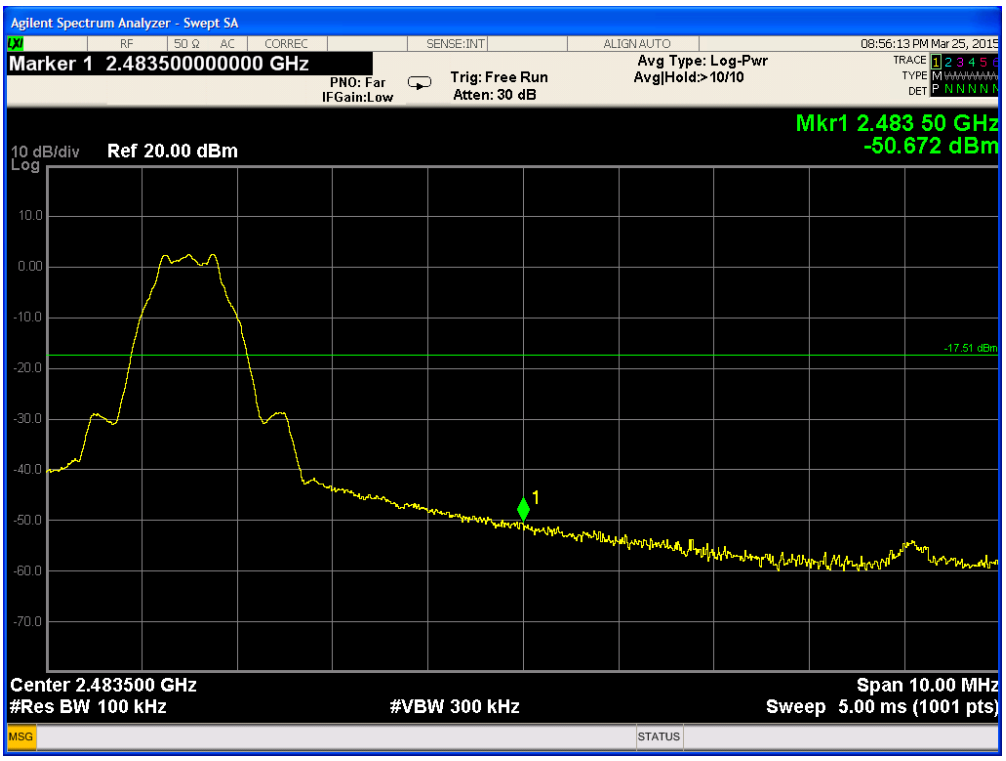
9.5.4 Test Result:

Pass.

9.5.5 Test Data:



Plot 9-16. Conducted-Low Band Edge (Ch. 0)



Plot 9-17. Conducted- High Band Edge (Ch. 39)

9.6 Radiated Spurious and Band Edge Emissions

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

9.6.2 Test Method:

Measurements are performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V03R02.

Radiated spurious measurements are made from 30MHz to the 10th harmonic of the fundamental frequency of the transmitter. The limit for radiated spurious emissions is per 15.209. Additionally, emissions found in the restricted bands as listed in 15.205 are tested for compliance per limits 15.209.

The EUT is tested near the low, middle and high channels of operation. Guidelines in ANSI C63.4:2009 were followed with respect to maximizing the emission by rotating the EUT in three orthogonal axes and adjusting the measurement antenna height and polarization. Worst case maximized data is shown in this test report.

A pre-amp and a high pass filter were required for this test, in order to provide the measuring system with sufficient sensitivity. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength.

Sample Calculation:

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

Spectrum Analyzer Settings:

30 MHz- 1 GHz:

RBW= 120 kHz
VBW ≥ 3 X RBW
Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector.
Span= 30 MHz- 1 GHz
Sweep time= Auto

Above 1 GHz:

RBW= 1 MHz
VBW= 3 MHz
Trace Mode: Peak Detector (Max Hold) and RMS Average Detector (Max Hold)
Span= 1- 18 GHz and 18- 26.5 GHz.
Sweep time= Auto

9.6.3 Limits:

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

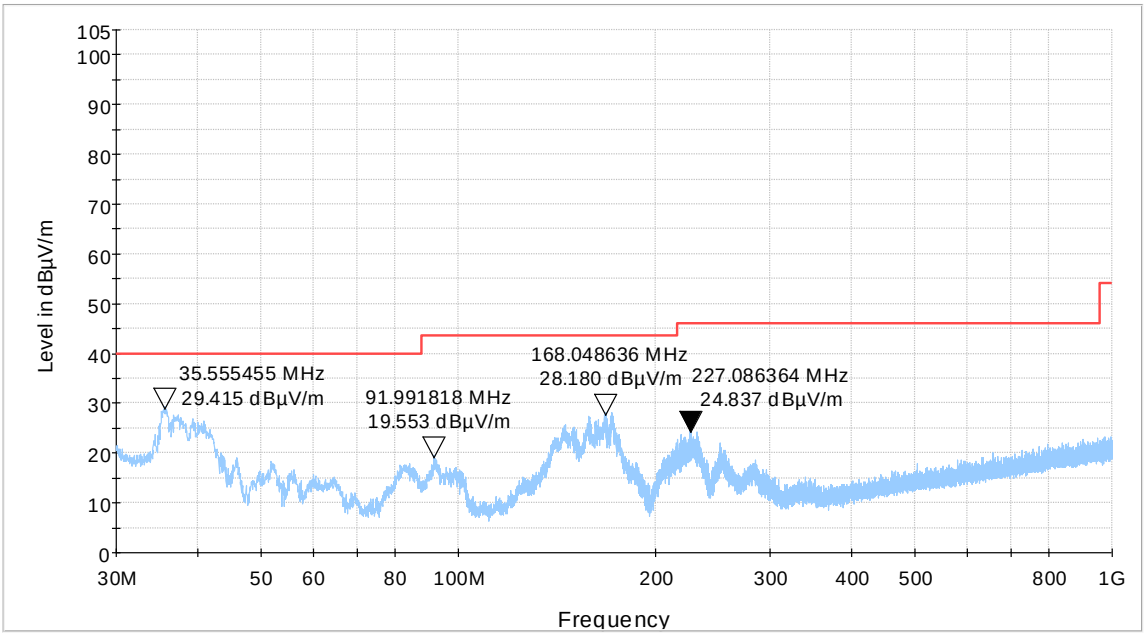
9.6.4 Test Result:

Pass.

9.6.5 Test Data:

9.6.5.1 Emissions in 30 MHz- 1 GHz range

Worst case emissions in mid channel of operation shown here.

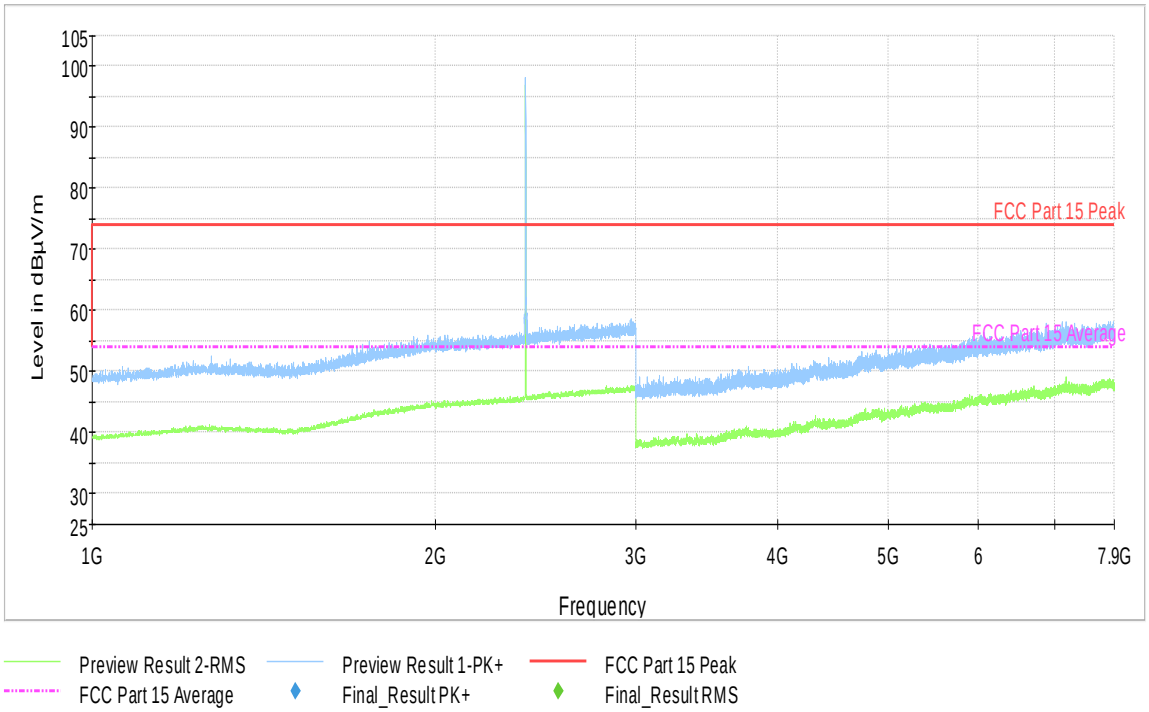


Plot 9-18. Radiated Spurious Emissions (Ch. 19) (30MHz - 1GHz)

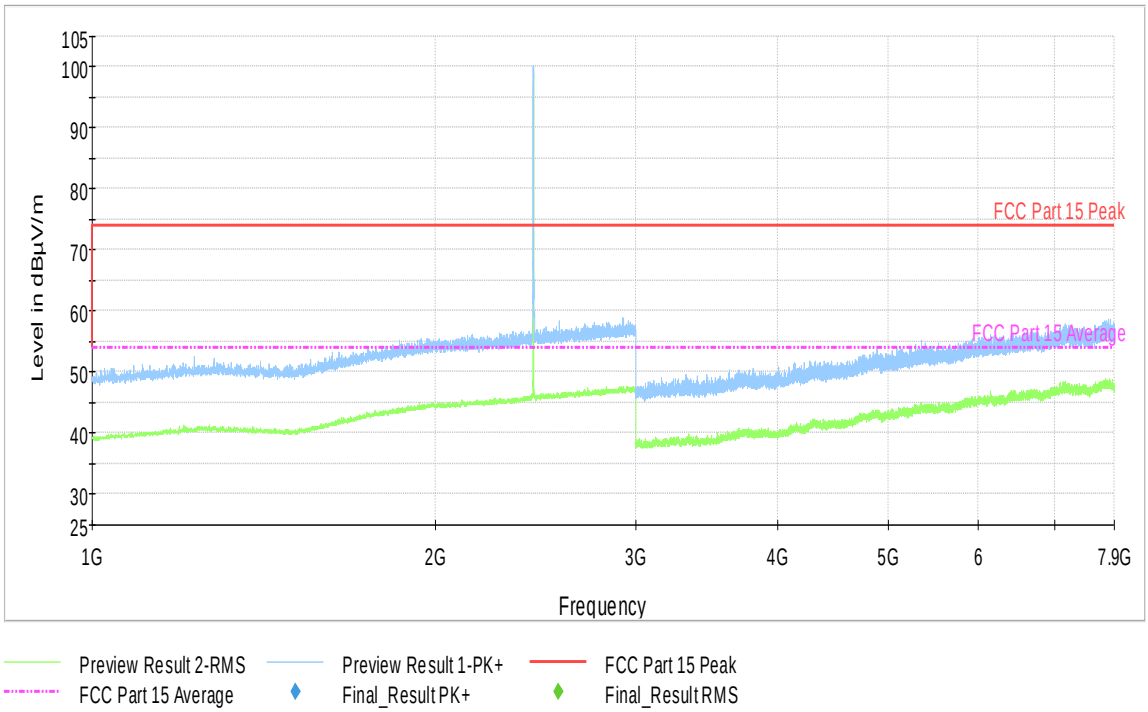
Frequency (MHz)	Raw Peak Field Strength (dBµV/m)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
35.56	16.32	-13.1	29.42	40	-10.58
91.99	-2.75	-22.3	19.55	43.5	-23.95
168.05	10.08	-18.1	28.18	43.5	-15.32
227.09	6.14	-18.7	24.84	46.0	-21.16

9.6.5.2 Emissions in 1-18 GHz range

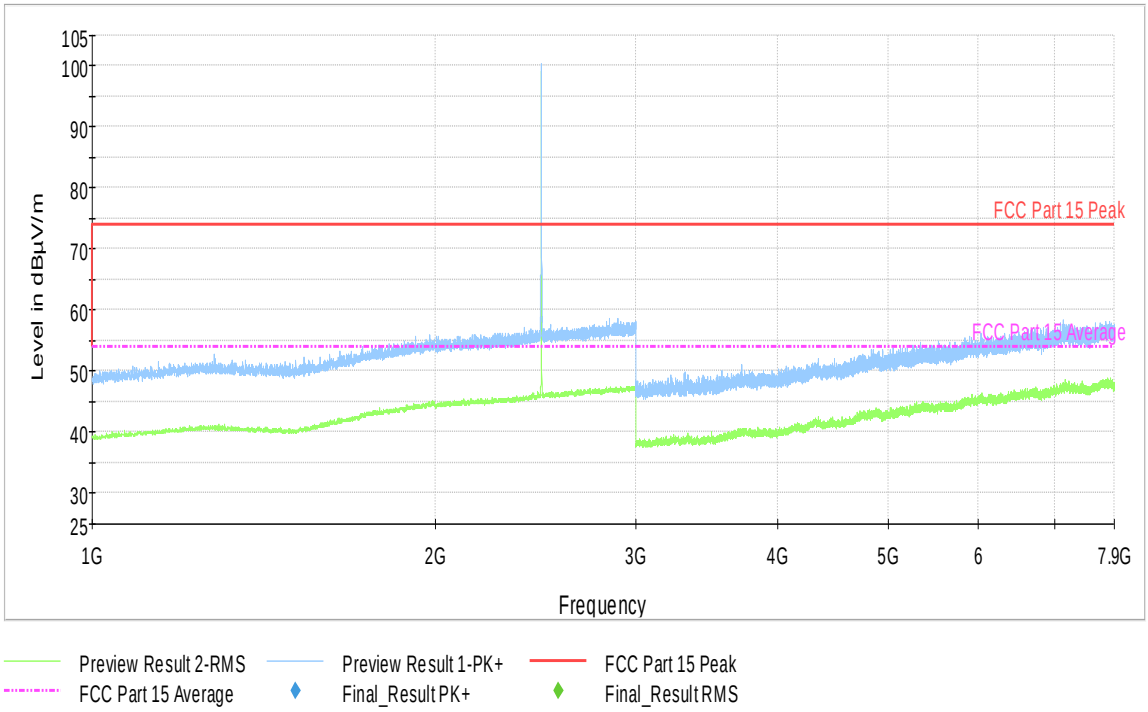
No significant emissions to report above noise floor.



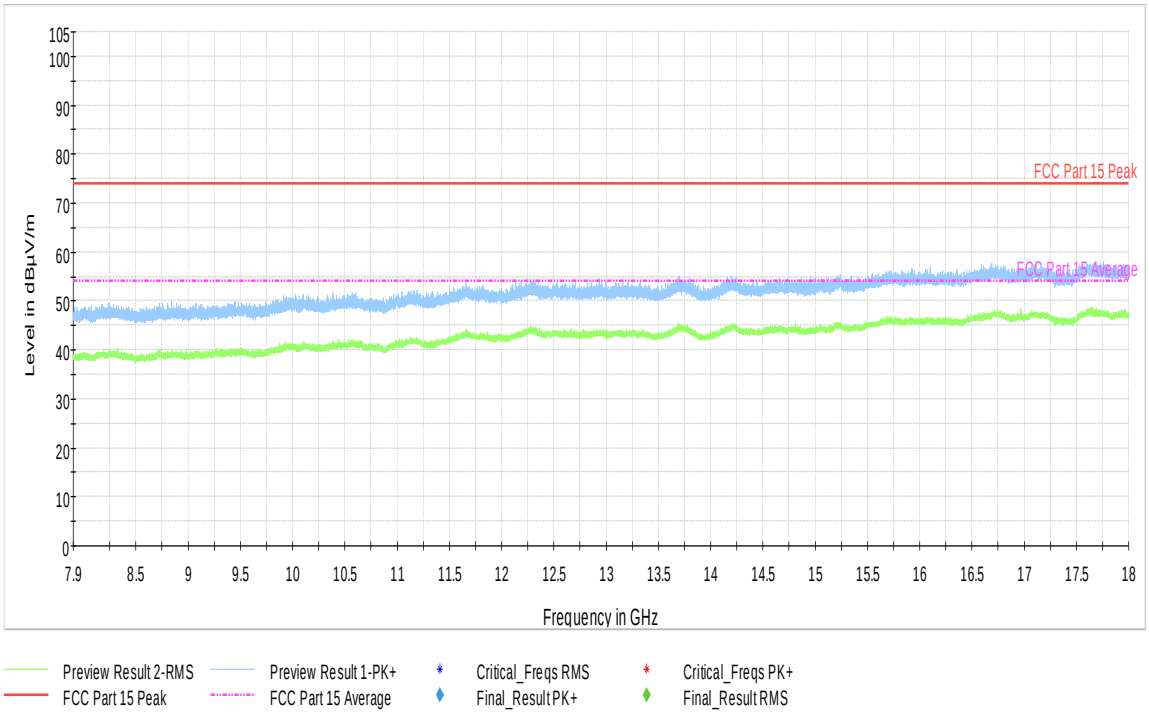
Plot 9-19. Radiated Spurious Emissions (Ch. 0) (1-7.9GHz)



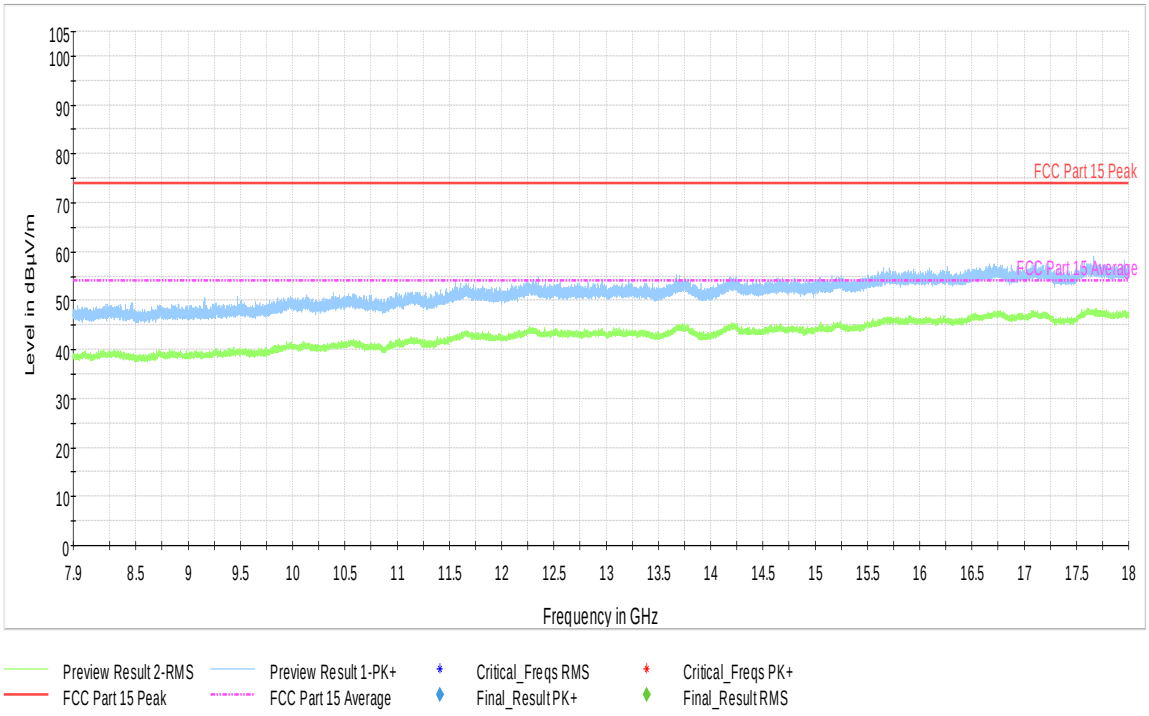
Plot 9-20. Radiated Spurious Emissions (Ch. 19) (1-7.9GHz)



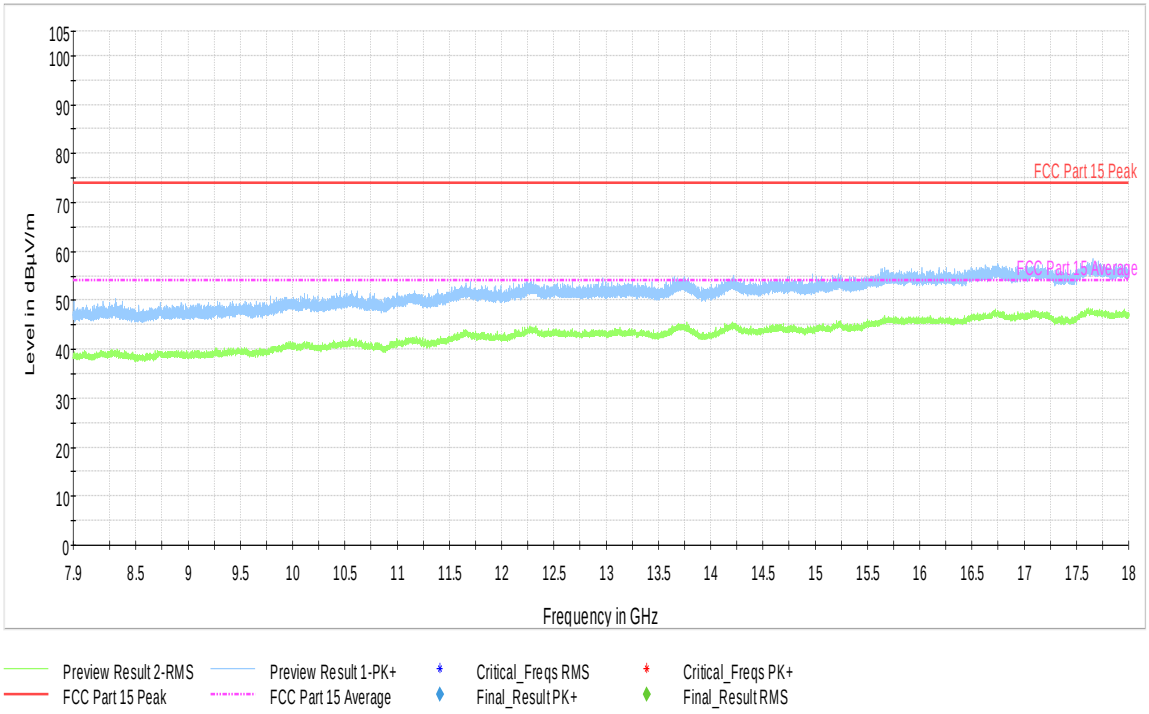
Plot 9-21. Radiated Spurious Emissions (Ch. 39) (1-7.9GHz)



Plot 9-22. Radiated Spurious Emissions (Ch. 0) (7.9-18 GHz)



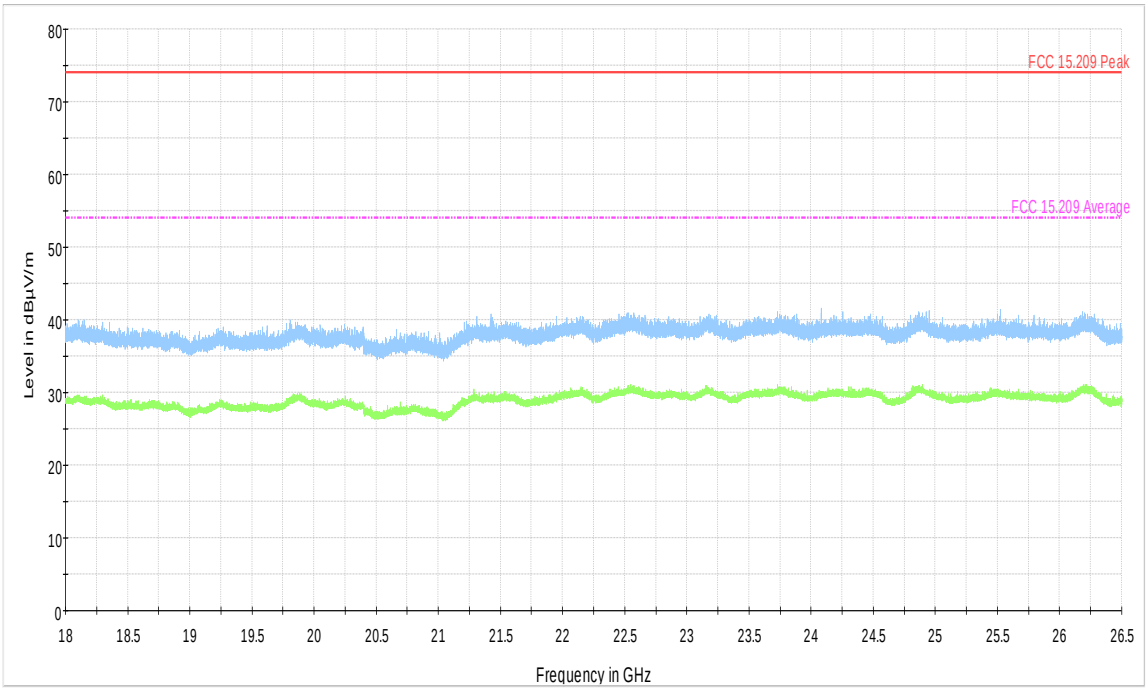
Plot 9-23. Radiated Spurious Emissions (Ch. 19) (7.9-18 GHz)



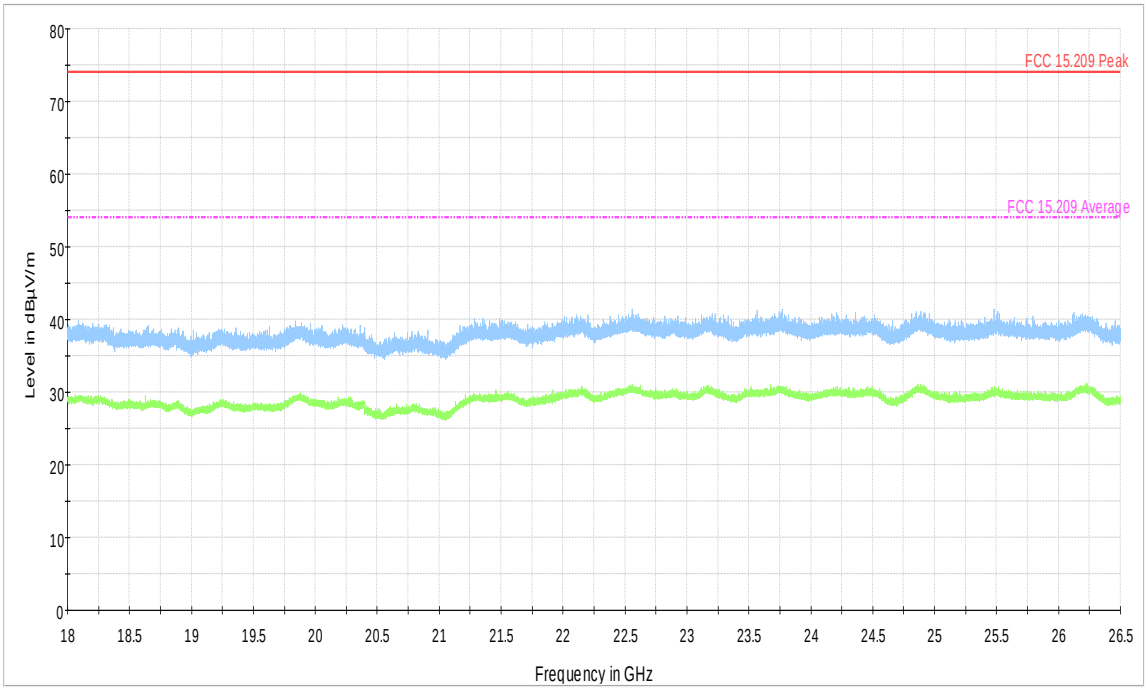
Plot 9-24. Radiated Spurious Emissions (Ch. 39) (7.9-18 GHz)

9.6.5.3 Emissions in 18-26.5 GHz range

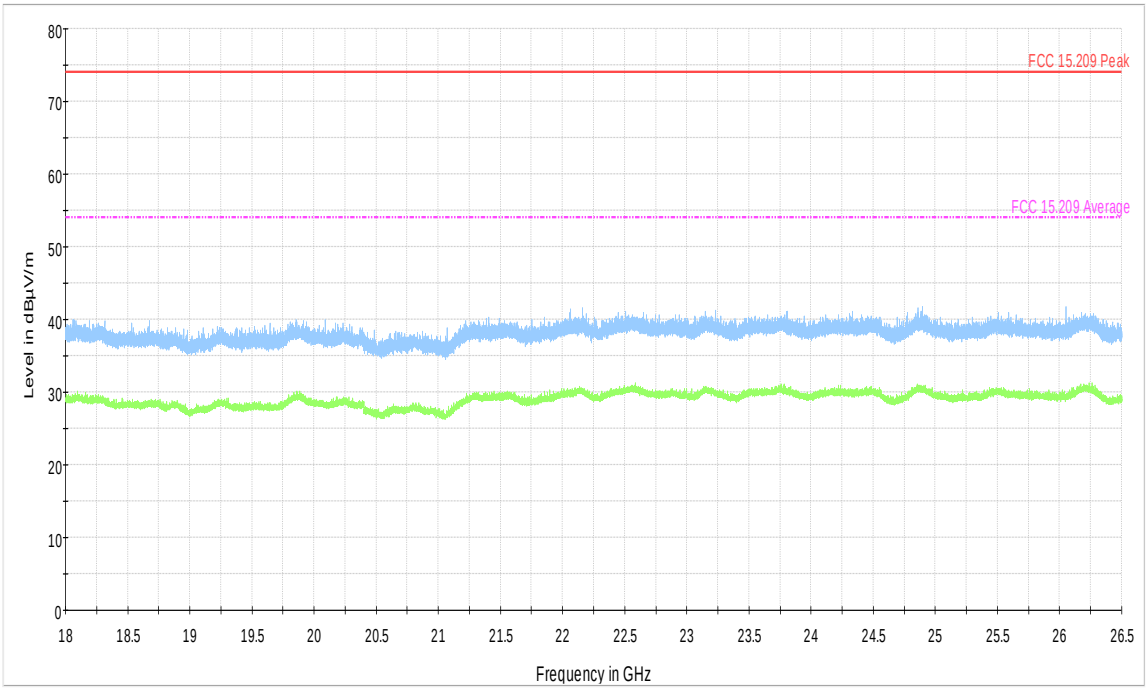
No significant emissions to report above noise floor.



Plot 9-25. Radiated Spurious Emissions (Ch. 0) (18 – 26.5 GHz)

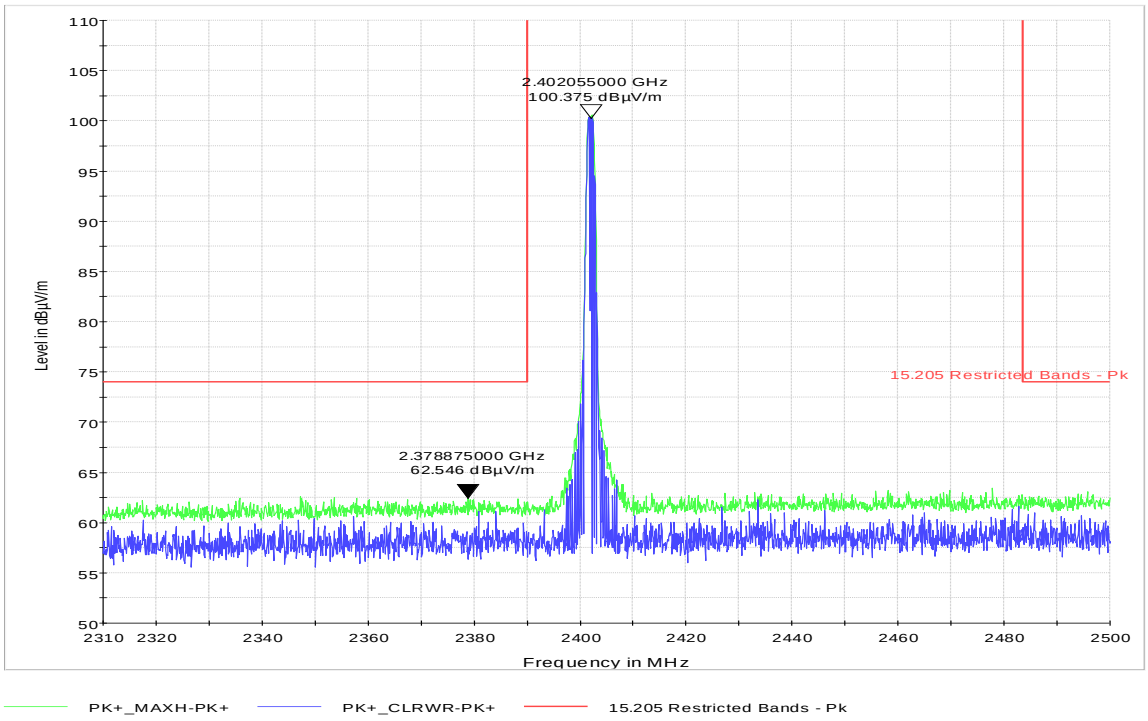


Plot 9-26. Radiated Spurious Emissions (Ch. 19) (18 – 26.5 GHz)

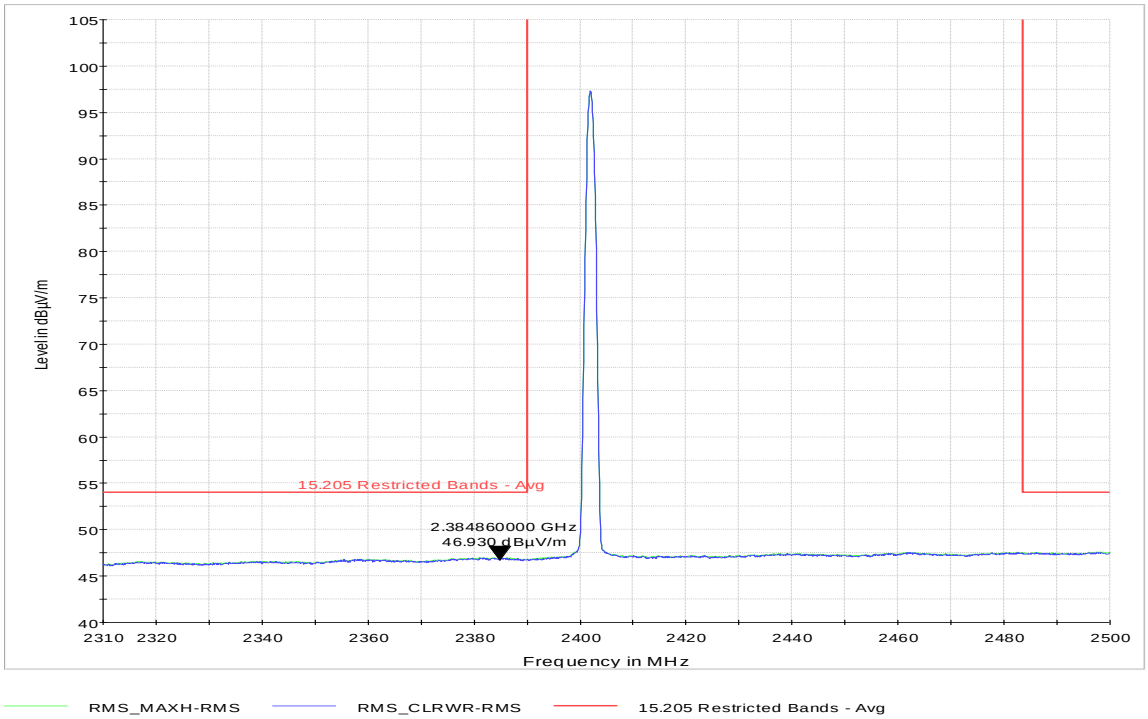


Plot 9-27. Radiated Spurious Emissions (Ch. 39) (18 – 26.5 GHz)

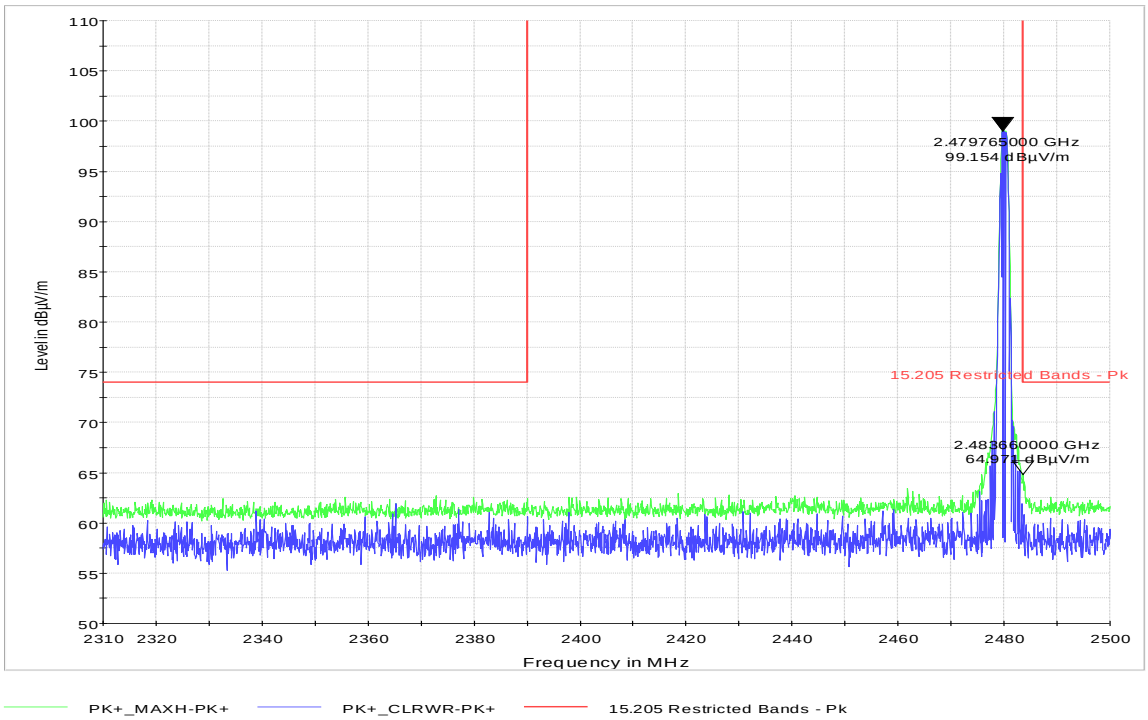
9.6.5.4 Radiated restricted Band-edge emissions



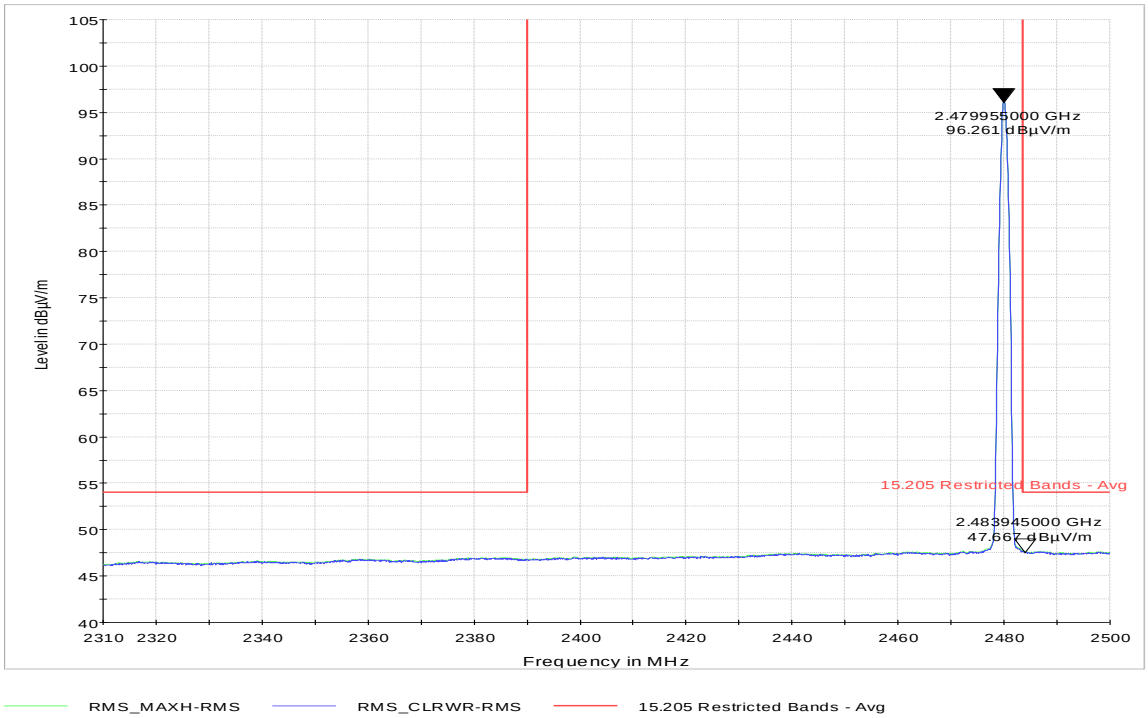
Plot 9-28. Radiated Restricted Band Edge (Ch. 0) Peak



Plot 9-29. Radiated Restricted Band Edge (Ch. 0) Average



Plot 9-30. Radiated Restricted Band Edge (Ch. 39) Peak



Plot 9-31. Radiated Restricted Band Edge (Ch. 39) Average

9.7 AC Line Conducted Emissions

9.7.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)

9.7.2 Test Method

Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground 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.

EMI Receiver Settings:

150 kHz – 30 MHz:

RBW= 9 kHz
VBW ≥ 3 X RBW
Trace Mode: Peak Detector (Max Hold).
Final measurements performed using Quasi-Peak and Average Detectors.
Span= 150 kHz – 30 MHz
Sweep time= Auto

9.7.3 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

9.7.4 Equipment List:

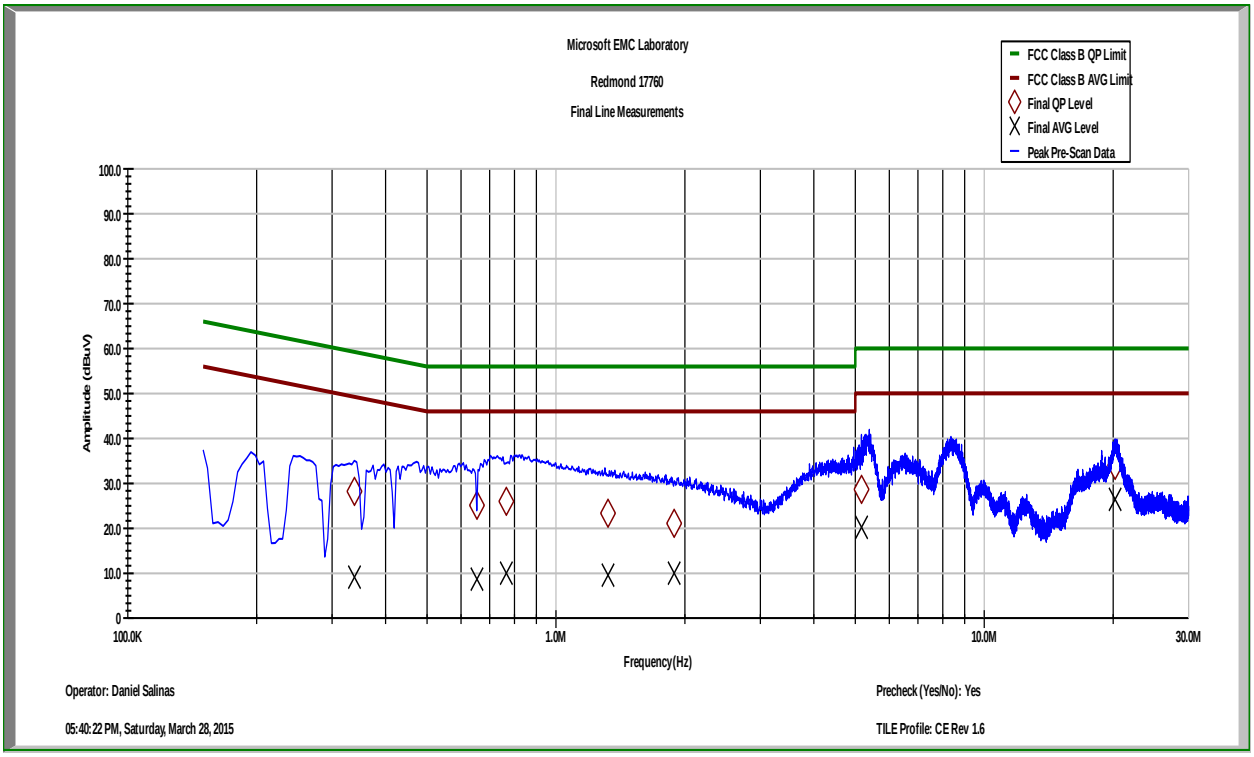
Description	Equipment ID	Last Cal Date	Cal Due Date
EMI Receiver	EMC-669	11/03/2014	11/03/2015
EUT LISN	EMC-187	10/11/2014	10/11/2015
AE LISN	EMC-057	05/08/2014	05/08/2015
Cable	EMC-367	N/A	N/A

9.7.5 Test Result:

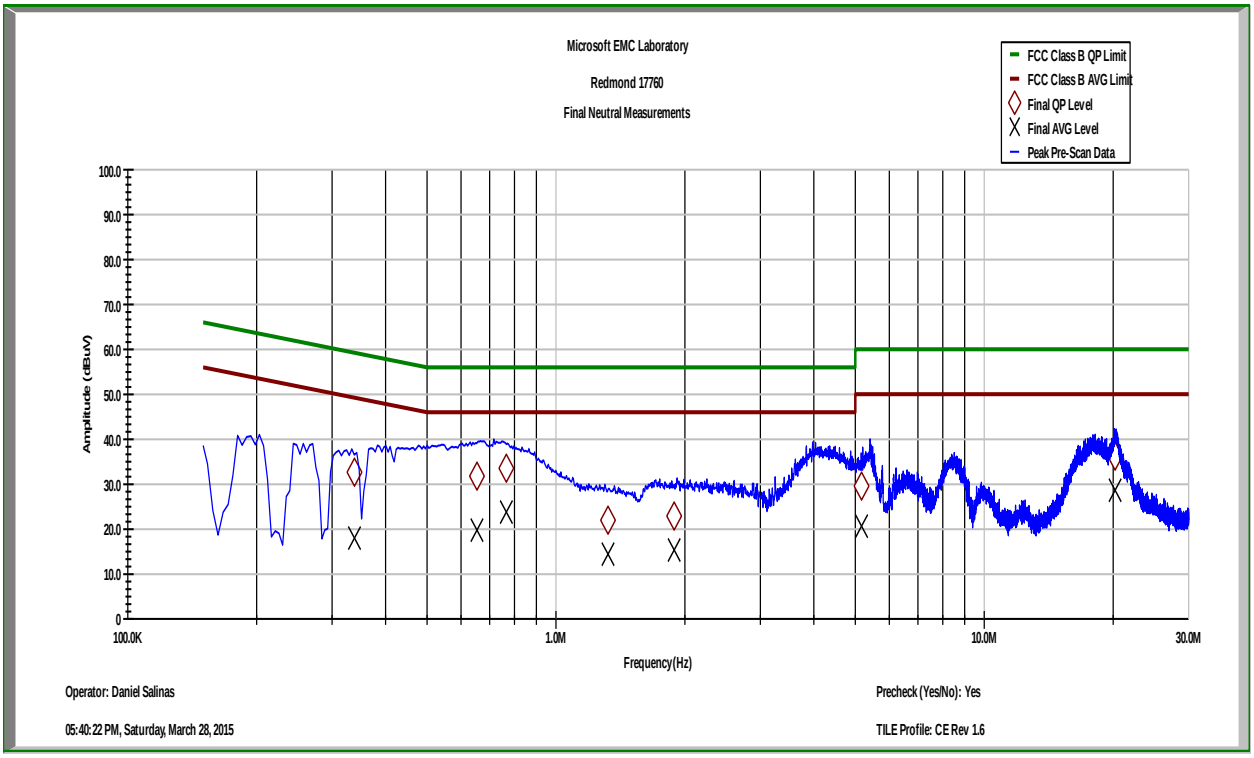
Pass

9.7.6 Test Data:

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)
0.34	28.01	9.08	61	51	L	-32.62	-41.55
0.65	25.08	8.68	56	46	L	-30.92	-37.32
0.77	26.17	9.88	56	46	L	-29.83	-36.12
1.32	23.22	9.58	56	46	L	-32.78	-36.42
1.88	21.06	9.95	56	46	L	-34.94	-36.05
5.17	28.57	20.24	60	50	L	-31.43	-29.76
20.16	33.87	26.29	60	50	L	-26.13	-23.71
0.34	32.76	17.83	61	51	N	-27.87	-32.8
0.65	31.87	19.81	56	46	N	-24.13	-26.19
0.77	33.41	23.86	56	46	N	-22.59	-22.14
1.32	21.97	14.41	56	46	N	-34.03	-31.59
1.88	22.75	15.09	56	46	N	-33.25	-30.91
5.17	29.36	20.66	60	50	N	-30.64	-29.34
20.16	36.08	28.79	60	50	N	-23.92	-21.21



Plot 9-32. AC Line Conducted Emissions- Line (150 kHz- 30 MHz)



Plot 9-33. AC Line Conducted Emissions- Neutral (150 kHz- 30 MHz)

Microsoft

End of Report