RADIO TEST REPORT

For

MODEL NO. 1634
FCC ID: C3K1634

Test Report No. R-TR69-FCC-3
Issue Date: 06/09/2015

FCC CFR47 Part 15 Subpart C

Prepared by
Microsoft EMC Laboratory
17760 NE 67th Ct,
Redmond WA, 98052, U.S.A.
425-421-9799
sajose@microsoft.com

A2LA ACCREDITED
TESTING CERT #3472.01

1 Record of Revisions

Revision	Date	Section	Page(s)	Summary of Changes	Author/Revised By:
1.0	03/18/2015	All	All	First Version	Daniel Salinas
2.0	06/02/2015	All 5, 9.2, 9.3	All 7, 16,19	Removed references to IC standards. Updated EUT description. Updated Duty cycle.	Daniel Salinas
3.0	06/09/2015	9.1, 9.2, 9.5	13-17, 31-33	Added Duty cycle plots and updated Occupied bandwidth plots. Updated Conducted Emissions test data using module.	Daniel Salinas

Microsoft

Table of Contents

Test Report Attestation

Microsoft Corporation
Model: 1634
FCC ID: C3K1634

Applicable Standards

Specification	Test Result
FCC CFR47 Rule Parts 15.207, 15.209 and 15.249	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 requires prior written approval of Microsoft EMC Laboratory.
This report replaces the previously issued test reports #R-TR69-FCC-1 and R-TR69-FCC-2 from Microsoft EMC Labs.

Written By: Daniel Salinas
Radio Test Lead

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 levels are for reference only and not applied to determine compliance of the EUT.
Expanded uncertainty calculations are available upon request.

Test item	Value (dB)
Radiated disturbance (30 MHz to 1 GHz)	6.01
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:	Kitty Tam
Functional Description of the EUT:	Base Station
Model:	1634
FCC ID:	C3K1634
Frequency Range of Operation:	2404- 2477 MHz
Antenna Type and Gain:	Loop Antenna with 2dBi gain
Modulation:	GFSK
EUT Classification:	Low Power Communication Device Transmitter
Approval Type:	Modular
Equipment Design State:	DV (Pre-production)
Equipment Condition:	Good

5.1 Test Configurations

Test Software Details: Newcap V0.9.1327 test software was used to force the EUT to transmit with the highest possible duty cycle rate.

Modes of Operation and Channel Details: GFSK modulation, on 2404 MHz, 2440 MHz, and 2477 MHz channels.

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

December 12-17, 2014; March 09, 2015; May 27-28, 2015; June 8, 2015

6 Test Results Summary

Test Description	FCC CFR 47	Limit	Test Result
Duty Cycle	15.35 (c), 15.249 (a), 15.205, 15.209	Measurement Purposes	N/A
Occupied Bandwidth	Reporting Purposes Only		N/A
Fundamental Field Strength	15.249 (a)	< 50 mV/m	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	Spectrum Analyzer	N9030A	RF-011	06/06/2015**
Agilent	Spectrum Analyzer	N9030A	EMC-061	02/04/2016
Teseq	LISN	NNB 51	EMC-187	10/11/2015
Rhode & Schwarz	EMI Receiver	ESU40	RF-192	04/15/2016
Rhode & Schwarz	EMI Receiver	ESR	EMC-669	11/03/2015
ETS-Lindgren	Antenna	3117	RF-137	03/30/2016
ETS-Lindgren	Antenna	3160-09	RF-037	N/A- Standard Gain Horn Antenna
ETS-Lindgren	Antenna	JB6	RF-039	05/05/2015**
Micro-Tronix	Notch Filter	BRM50702-02	RF-055	N/A*
Rohde & Schwarz	Pre-Amp	TS-PR18	RF-041	N/A*
Rohde & Schwarz	Pre-Amp	TS-PR26	RF-042	N/A*
Rohde & Schwarz	EMI Test Receiver	ESU40	RF-012	04/13/2016
Rohde & Schwarz	Switch Control Unit	OSP130	RF-018	N/A*
Rohde & Schwarz	Switch Control Unit	OSP150	RF-019	N/A*
Rosenburger	RF Cable	L72-449-915	EMC-326	N/A*
Rohde & Schwarz	Software	EMC-32 V9.15	N/A	N/A

*Note: The calibrations of the measuring instruments, including any accessories that may affect such calibration, are checked frequently to ensure their accuracy. Items listed as “N/A” have regular in house characterizations.
**Note: Equipment was within calibration during dates of testing.

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

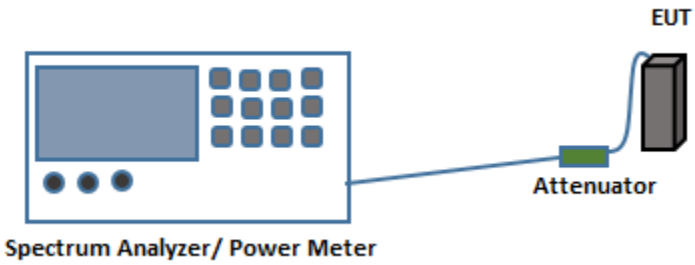

Fig.1. Test Setup for Antenna port conducted measurements

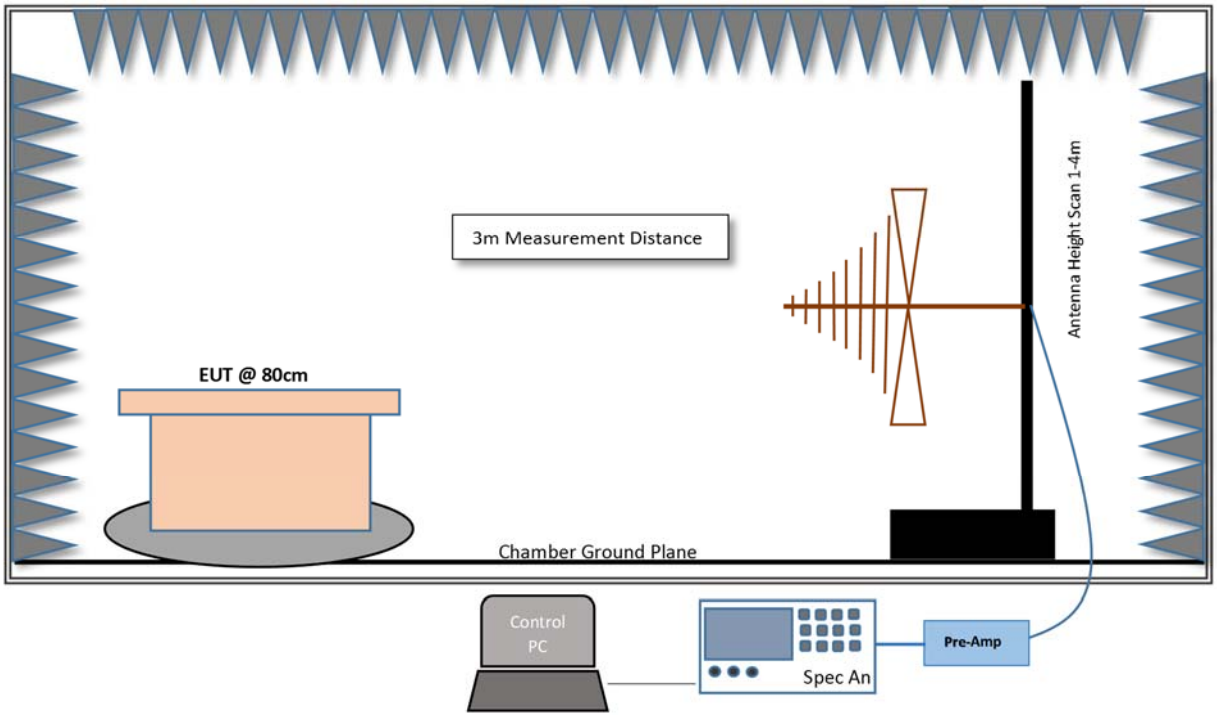

Fig.2. Test Setup for Radiated measurements in 30MHz- 1GHz Range

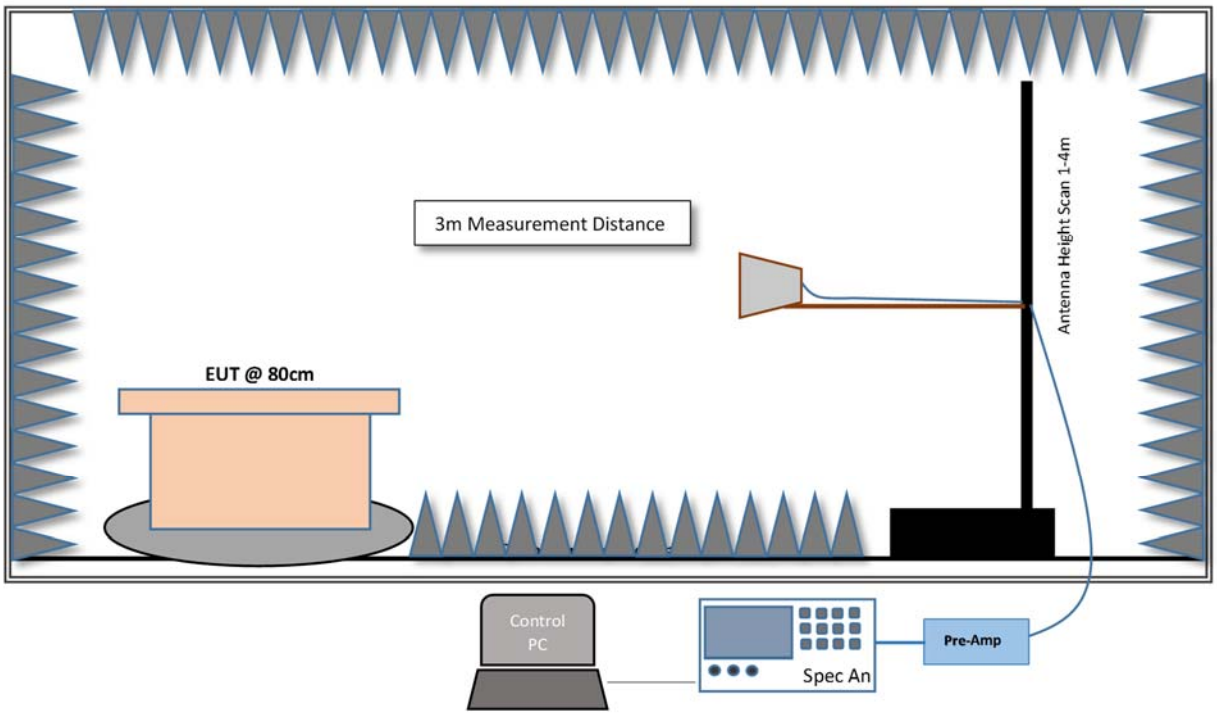

Fig.3. Test Setup for Radiated measurements in 1GHz- 18GHz Range

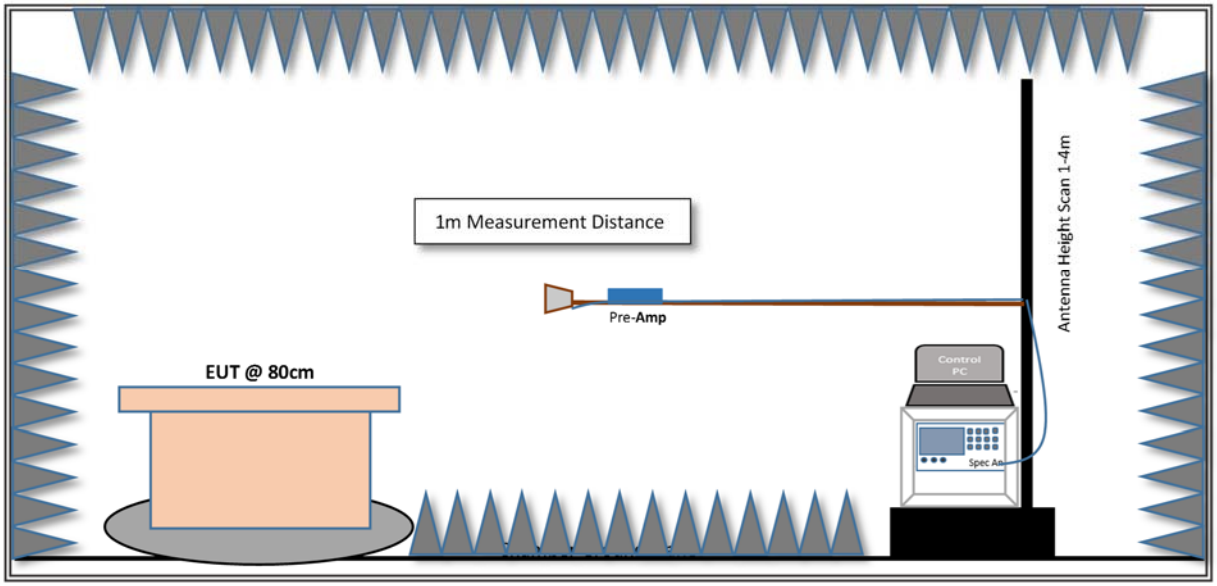

Fig.4. Test Setup for Radiated measurements >18GHz

9 Test Results

9.1 Duty Cycle

9.1.1 Test Requirements:

Duty cycle is used to calculate the average value of pulsed emissions for as specified in section 15.35 (c) for sections 15.249 (a), 15.205, and 15.209 in Title 47 CFR.

9.1.2 Test Method:

The EUT was tested in accordance with section 7.5 of ANSI C63.10:2009.

Spectrum Analyzer Settings:
RBW = 3 MHz
VBW > 3 x RBW
Trace Mode: Peak Detector (Max Hold)
Span = 0 Hz
Sweep time = 15ms; 100ms

Duty cycle is calculated by dividing the aggregate on time of the transmission train in a 100ms period by 100ms and multiplying by 100%. The aggregate on time of a periodic signal is the on time of a single pulse multiplied by the pulse count in a 100ms measurement time.

$$Duty\ cycle\ = \frac{(1.218ms \times 12)}{100ms} \times\ 100\% = 14.616\%$$

9.1.3 Limits:

Measurement purposes only.

9.1.4 Test Data:

Transmitter On Time (ms)	Number of Pulses over 100 ms pulse train	Duty Cycle (%)
1.218	12	14.616

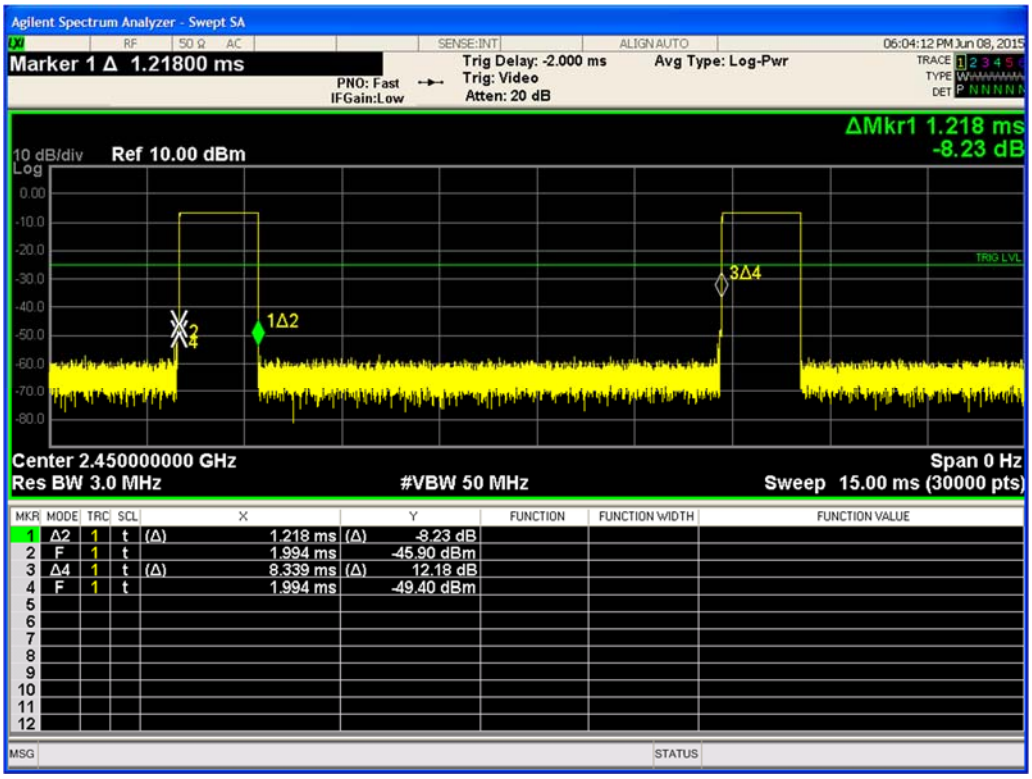

Figure 9-1 Transmitter On Time and Period

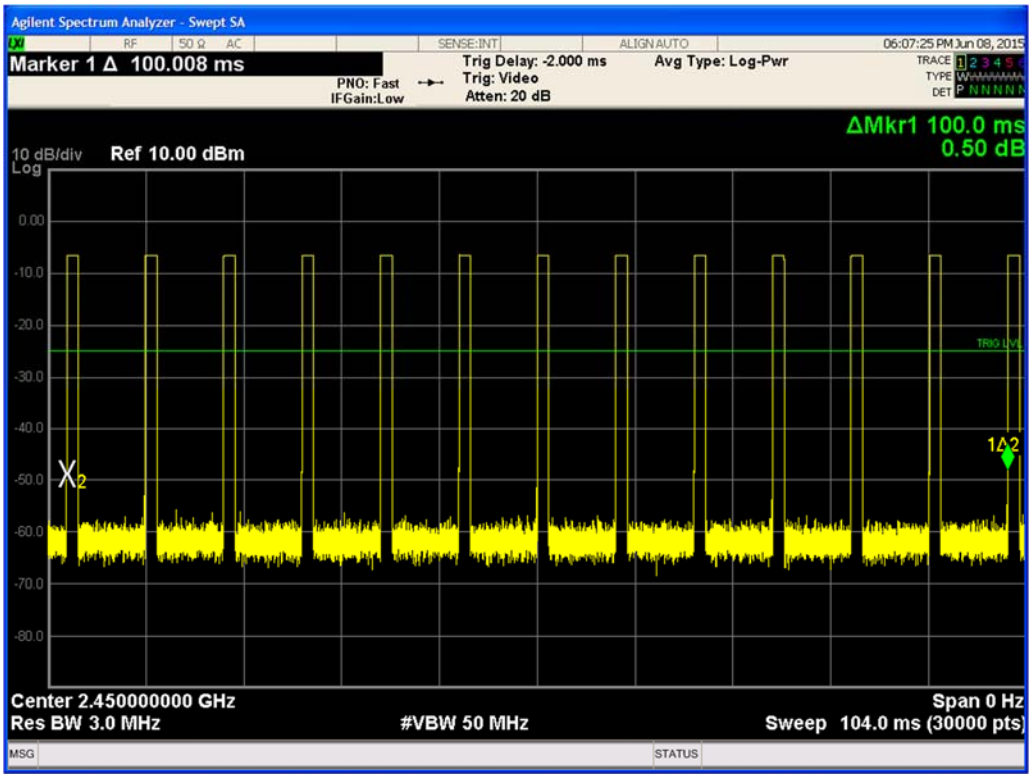

Figure 9-2 Pulse Train over 100ms

9.2 Occupied Bandwidth

9.2.1 Test Requirements:

Reporting purposes only

9.2.2 Test Method:

The EUT is tested in low, middle and high channels.

Spectrum Analyzer Settings:
RBW= 1-5% of Occupied Bandwidth
VBW > 3 x RBW
Trace Mode: Peak Detector (Max Hold)
Span = 5 MHz
Sweep time = Auto
Measurement Function: 99%

9.2.3 Limits:

Reporting purpose only.

9.2.4 Test Data:

Figure 9-3 99% Occupied Bandwidth (2404 MHz)

Figure 9-4 99% Occupied Bandwidth (2440 MHz)

Figure 9-5 99% Occupied Bandwidth (2477 MHz)

9.3 Fundamental Field Strength

9.3.1 Test Requirements:

FCC CFR 47 Rule Part 15.249 (a)

9.3.2 Test Method:

Field Strength Measurements are performed according to the procedures defined in ANSI C63.4 2009.

The EUT is tested in the low, middle and high channels and in three orthogonal axes. Antenna height and polarities are adjusted to record the maximum emissions and the worst case data is presented below.

For testing purposes, the EUT was forced to transmit at a higher duty cycle of 66.5%. According to the manufacturer, the maximum duty cycle under normal operation is 14.6%. The maximum duty cycle under normal operation of 14.6% was used to calculate average field strength values.

Spectrum Analyzer Settings:

Peak Measurements:

RBW= 1 MHz
VBW= 3 MHz
Trace Mode: Peak Detector (Max Hold)
Span= 2.4 to 2.4834 GHz
Sweep time= Auto

Average measurements are calculated by applying the maximum operational duty cycle correction factor of the device according to ANSI C63.4 2009 section 13.4.2.

Duty Cycle Correction Factor (dB) = $20\ log\ (x)$ = $20\log(0.146)$ = -16.71 dB

where x is the duty cycle.

Average measurement= Peak Measurement+ Duty Cycle Correction Factor.

Sample Calculations:

Electric Field Strength Level = Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) – Amplifier Gain + DCF (Duty Cycle Factor)
Eg: Electric Field Strength = 96 dBµV+ 12 dB - 10 dB= 98 dBµV/m

9.3.3 Limits:

Frequency (MHz)	Average Field Strength (mV/m)	Measurement Distance (Meters)	Corrected Field Strength (dBµV/m)
2400 – 2483.5	50	3	94

Peak emissions may not exceed average limits by more than 20 dB.

9.3.4 Test Data:

Carrier Frequency (MHz)	Peak Field Strength (dBµV/m)	Detector	Peak Limit (dBµV/m)	Margin (dB)	Result
2404	95.87	Peak	114	-18.13	Pass
2440	95.16	Peak	114	-18.84	Pass
2477	92.28	Peak	114	-21.72	Pass

Carrier Frequency (MHz)	Peak Field Strength (dBµV/m)	Normal Operation Duty Cycle (%)	Duty Cycle Factor (dB)	Calculated Average Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2404	95.87	14.6	-16.71	79.16	94	-14.84	Pass
2440	95.16	14.6	-16.71	78.45	94	-15.55	Pass
2477	92.28	14.6	-16.71	75.57	94	-18.43	Pass

9.3.4.1 Fundamental Field Strength:

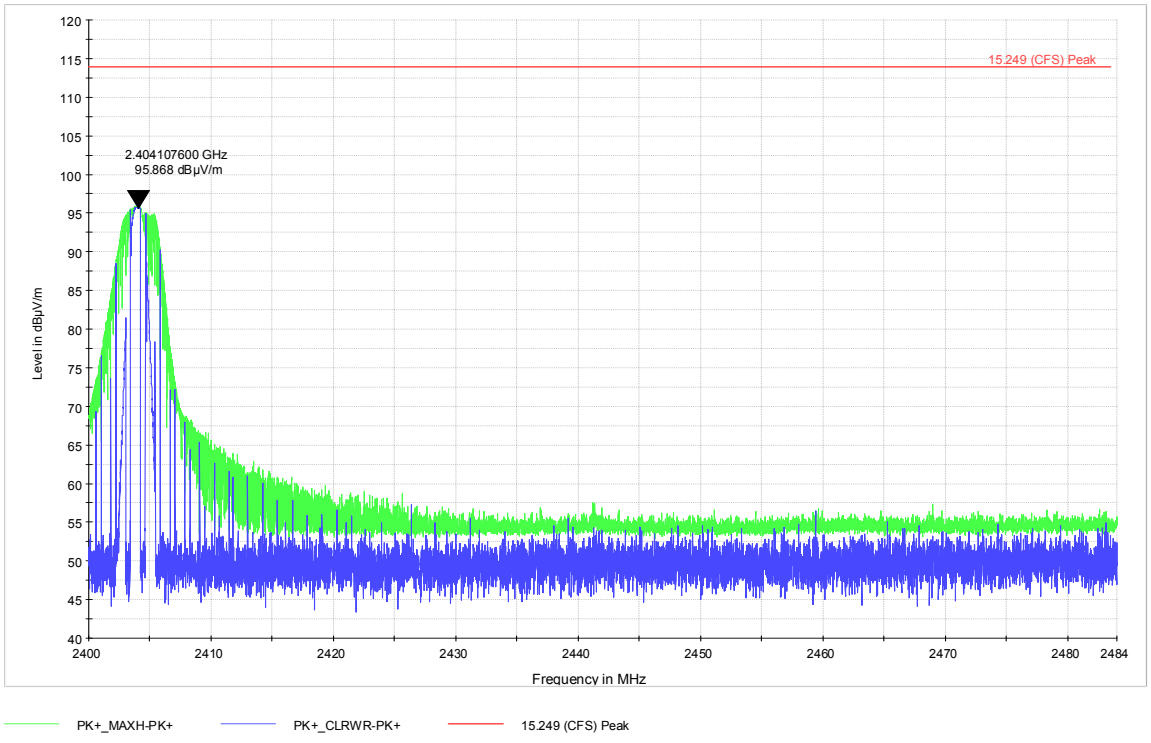

Figure 9-6 Fundamental Field Strength (2404 MHz) Peak Detector

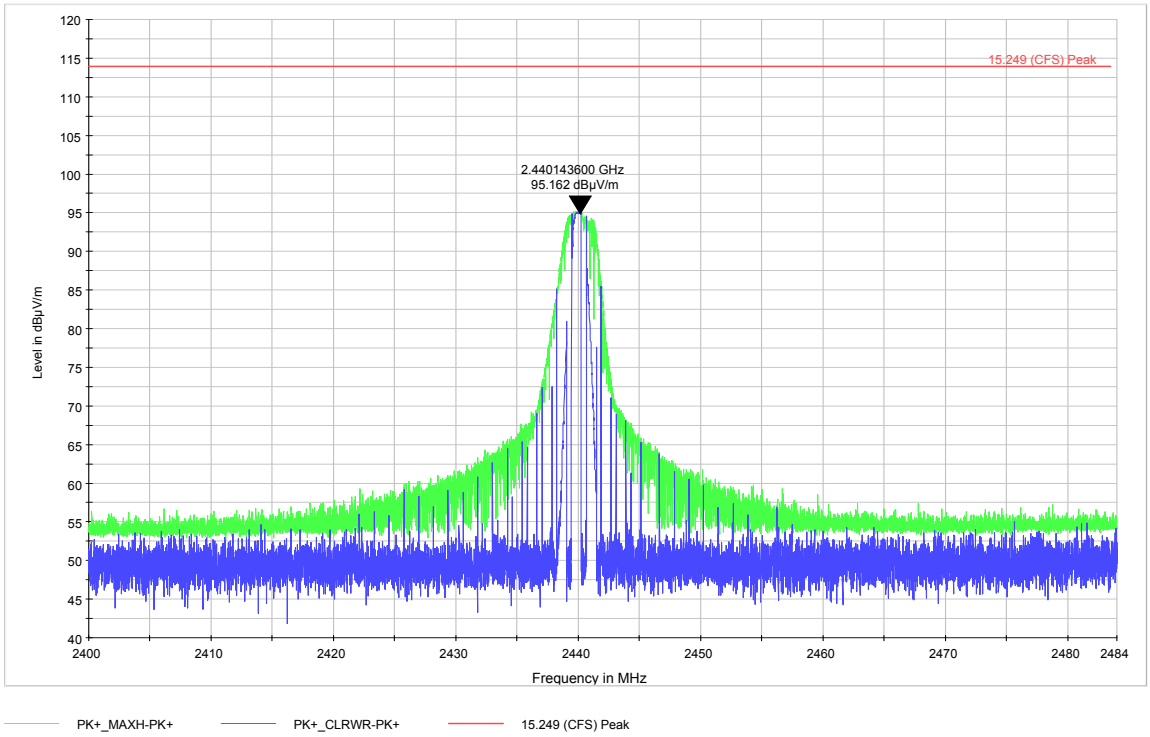

Figure 9-7 Fundamental Field Strength (2440 MHz) Peak Detector

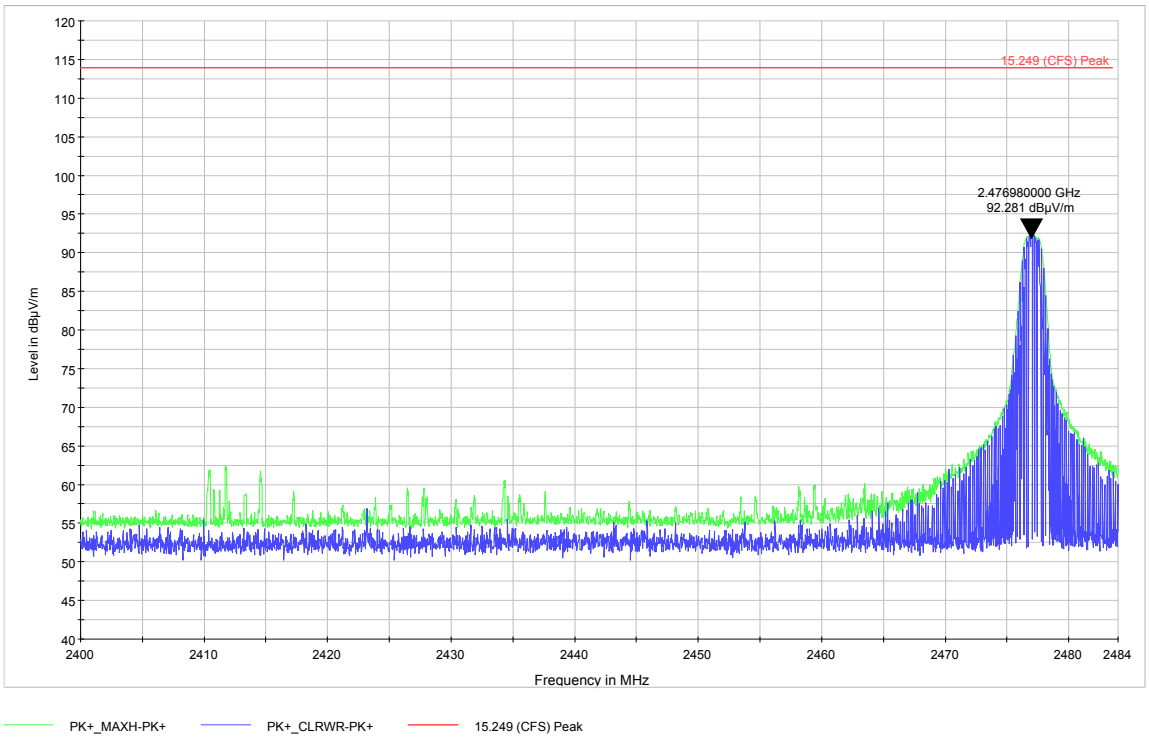

Figure 9-8 Fundamental Field Strength (2477 MHz) Peak Detector

9.4 Radiated Spurious and Band Edge Emissions

9.4.1 Test Requirement:

FCC CFR 47 Rule Part 15.249 (d)

9.4.2 Test Method:

Measurements are performed according to the procedures defined in ANSI C63.4 2009.

Radiated spurious emissions are checked from 30 MHz to the 10th harmonic of the highest fundamental frequency of the transmitter.

The EUT is tested in the low, middle and high channels and in three orthogonal axes. Antenna height and polarities are adjusted to record the maximum emissions and the worst case data is shown below.

For testing purposes, the EUT was set to transmit with a duty cycle of 66.5%. The maximum operational duty cycle of 14.6% was used to calculate average values as described in ANSI C63.4 2009.

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)
Span= 1- 18 GHz and 18- 26.5 GHz.
Sweep time= Auto

Average measurements are calculated by applying the maximum operational duty cycle correction factor of the device according to ANSI C63.4 2014 section 13.4.2.

Duty Cycle Correction Factor (dB) = $20\ log\ (x)$ = $20\log(0.146)$ = -16.71 dB

where x is the duty cycle.

Average measurement= Peak Measurement+ Duty Cycle Correction Factor.

Electric Field Strength Level = Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) – Amplifier Gain + DCF (Duty Cycle Factor)
Eg: Electric Field Strength = 96 dBµV+ 12 dB - 10 dB= 98 dBµV/m

9.4.3 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)

9.4.4 Test Result:

Pass.

9.4.5 Test Data:

9.4.5.1 Emissions in 30 MHz- 1 GHz range

Worst case results shown below.

Spurious Frequency (MHz)	Carrier Frequency (MHz)	Quasi-Peak Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.03	2440	25.96	40	-14.04
200.00	2440	32.92	43.5	-10.60
233.323	2440	30.69	46	-15.33
266.65	2440	33.26	46	-12.76
366.65	2440	29.40	46	-16.62
433.30	2440	34.15	46	-11.87
499.98	2440	32.08	46	-13.94
566.65	2440	28.85	46	-17.17
833.30	2440	29.90	46	-16.12
899.95	2440	33.27	46	-12.75

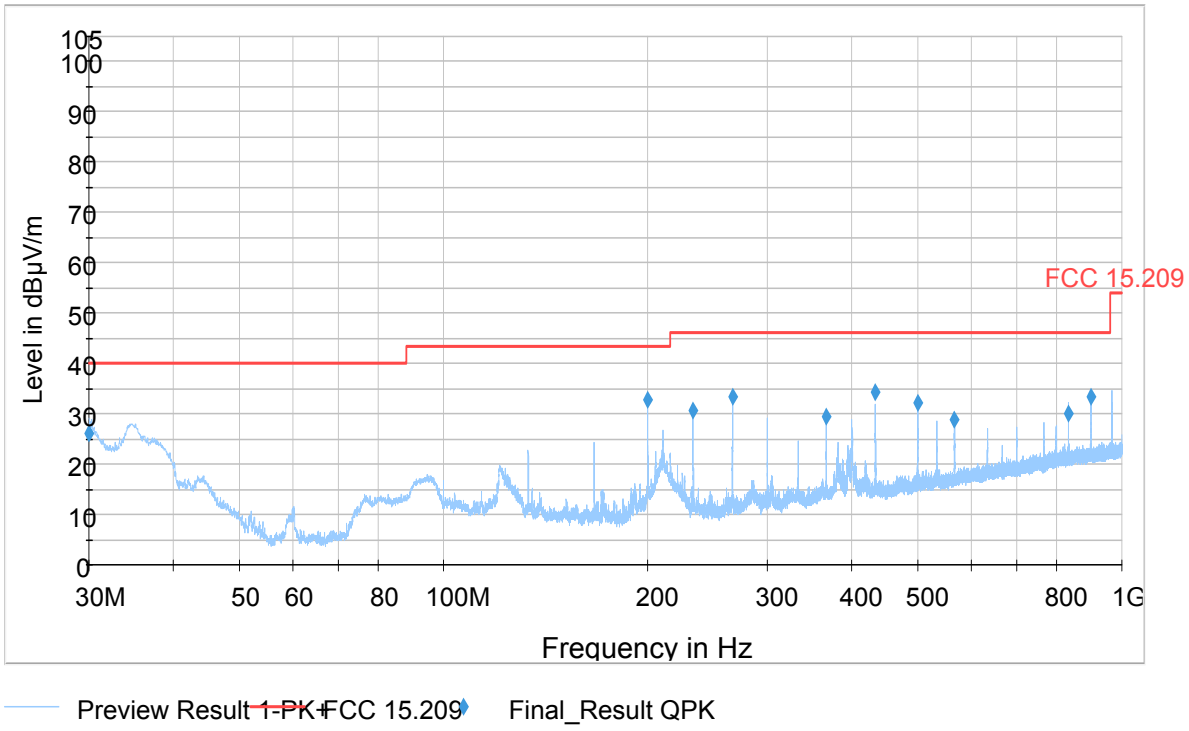

Figure 9-9 Radiated Spurious Emissions (2440 MHz) (30MHz - 1GHz)

9.4.5.2 Emissions in 1-7.9 GHz range

Spurious Frequency (MHz)	Carrier Frequency (MHz)	Detector Peak	Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin
4880.07	2440	Peak	62.35	74	-11.65
4808.03	2404	Peak	57.75	74	-16.25
4956.33	2477	Peak	61.5	74	-12.5
7431.13	2477	Peak	61.85	74	-12.15

Spurious Frequency (MHz)	Carrier Frequency (MHz)	Peak Field Strength (dBµV/m)	Duty Cycle Factor (dB)	Calculated Average Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin
4880.07	2440	62.35	-16.71	45.64	54	-8.36
4808.03	2404	57.75	-16.71	41.04	54	-12.96
4956.33	2477	60.45	-16.71	43.74	54	-10.26
7431.13	2477	61.85	-16.71	45.14	54	-8.86

Note: All plots were recorded with the EUT transmitting at a duty cycle of 66.5% in order to maximize the emissions. Final average data is calculated based on the EUT's normal operation duty cycle of 14.6% (duty cycle correction factor of -16.7 dB)

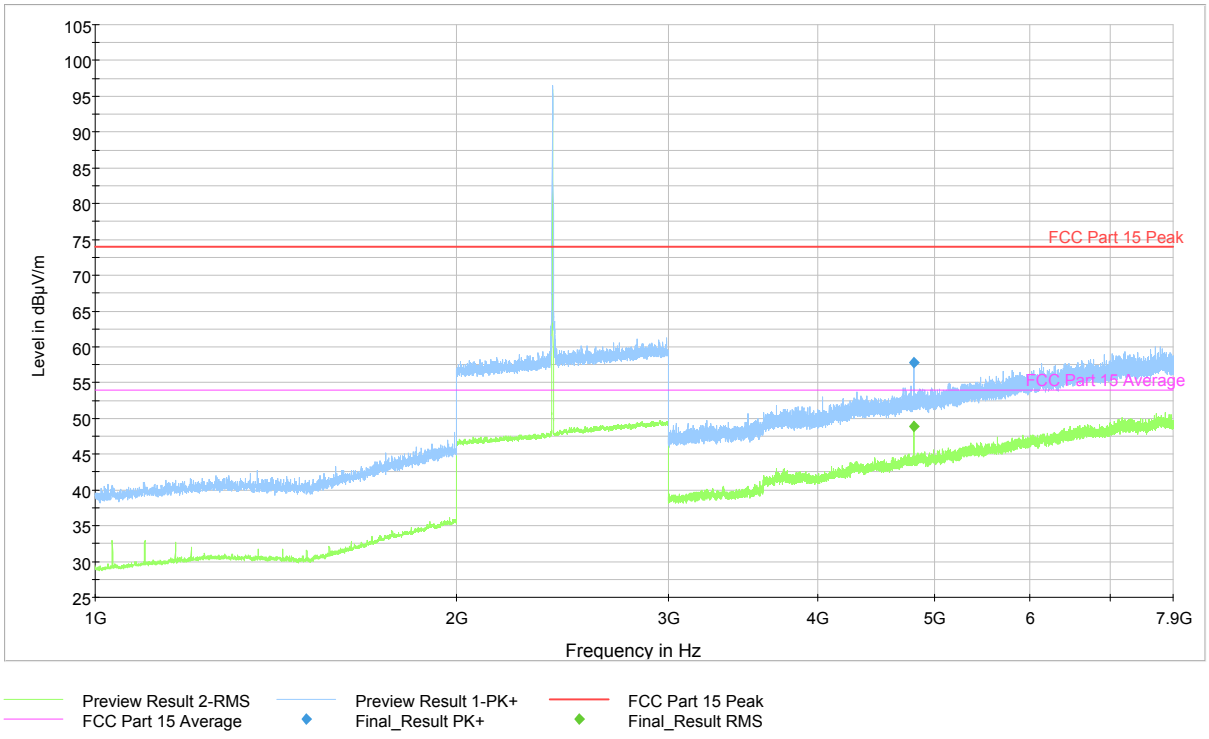

Figure 9-10 Radiated Spurious Emissions (2404 MHz) (1-7.9 GHz)

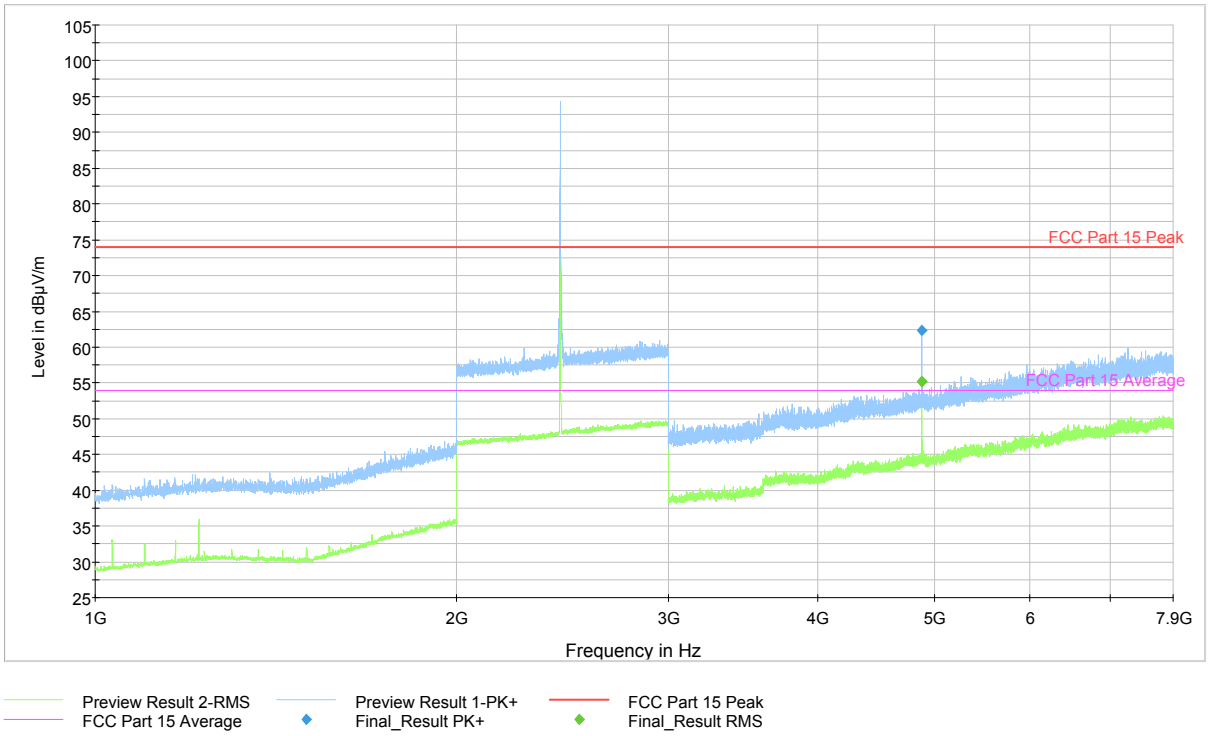

Figure 9-11 Radiated Spurious Emissions (2440 MHz) (1-7.9GHz)

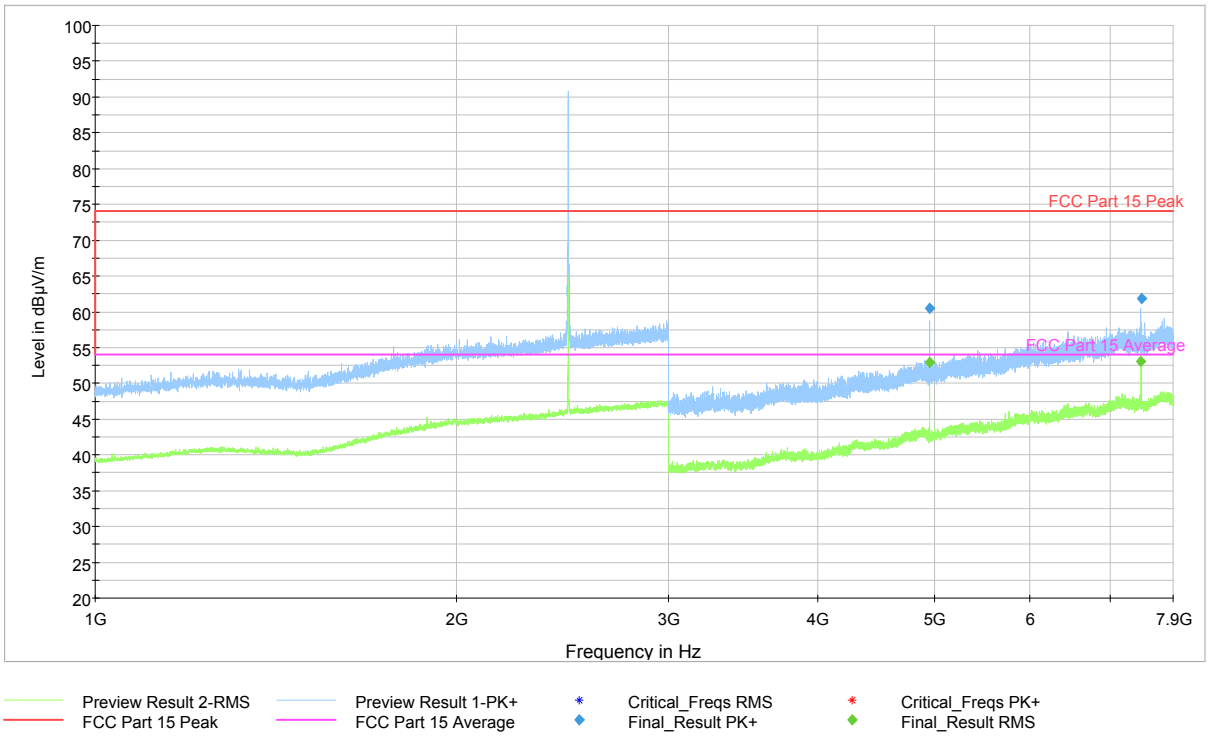

Figure 9-12 Radiated Spurious Emissions (2477 MHz) (1-7.9GHz)

9.4.5.3 Emissions in the 7.9-18GHz range

No significant emissions to report above the noise floor.

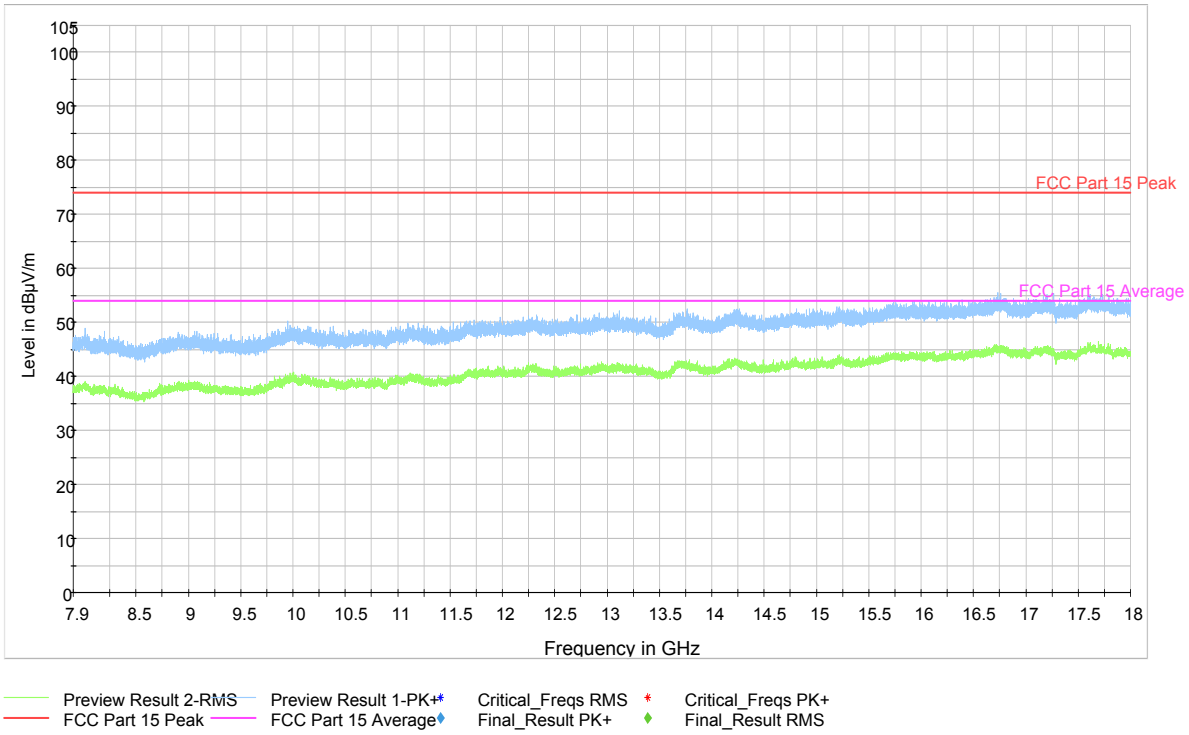

Figure 9-13 Radiated Spurious Emissions (2404 MHz) (7.9-18GHz)

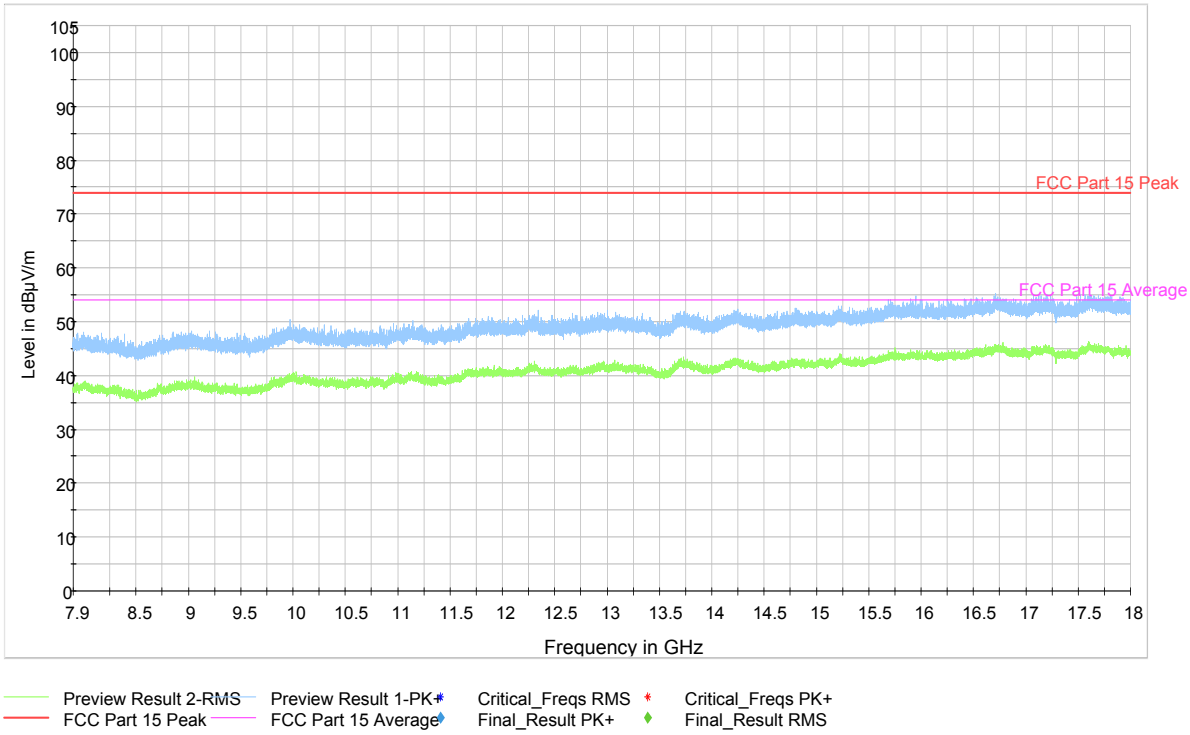

Figure 9-14 Radiated Spurious Emissions (2440 MHz) (7.9-18GHz)

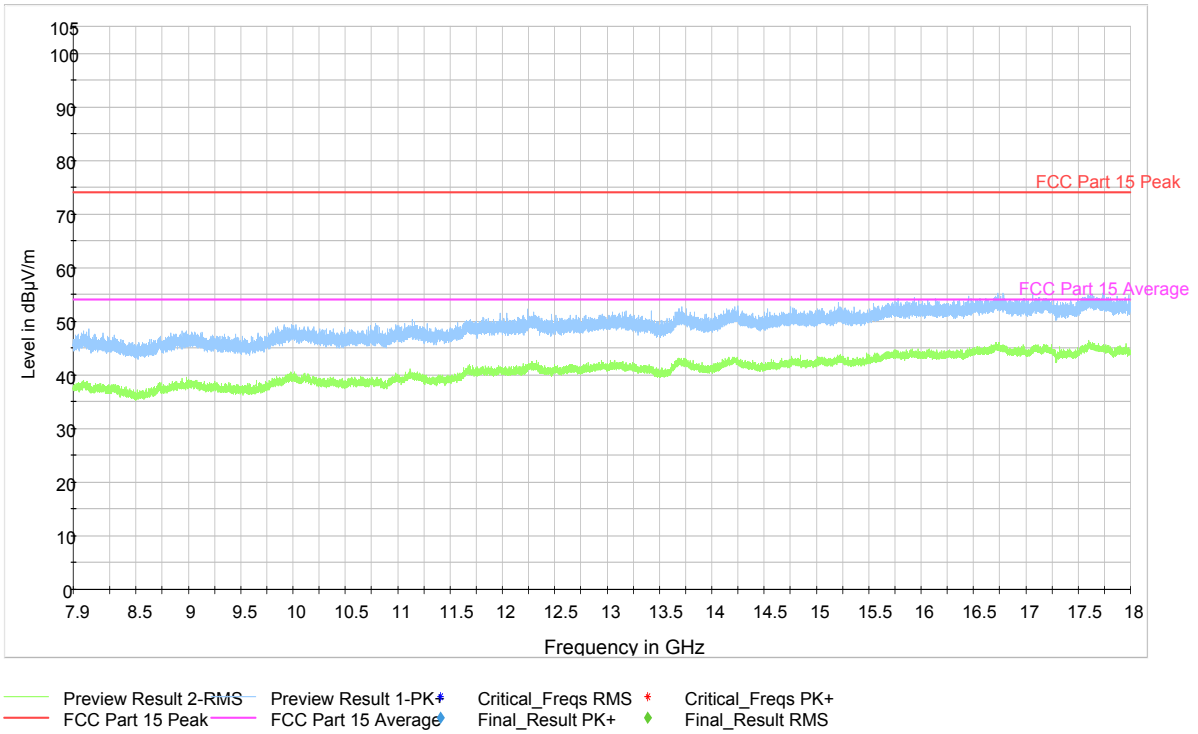

Figure 9-15 Radiated Spurious Emissions (2477 MHz) (7.9-18GHz)

9.4.5.4 Emissions in 18-26.5 GHz range

Worst case results shown below. No significant emissions to report above noise floor.

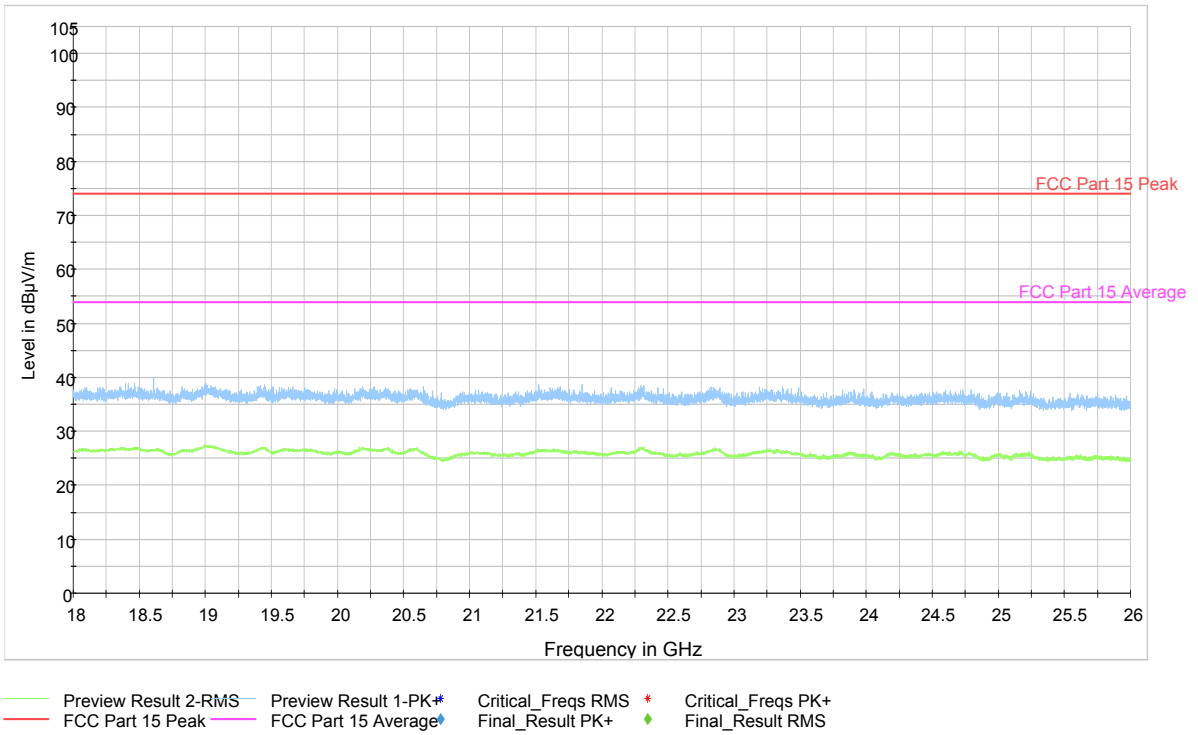

Figure 9-16 Radiated Spurious Emissions (2477 MHz) (18-26.5GHz)

9.4.5.5 *Radiated restricted Band-edge emissions*

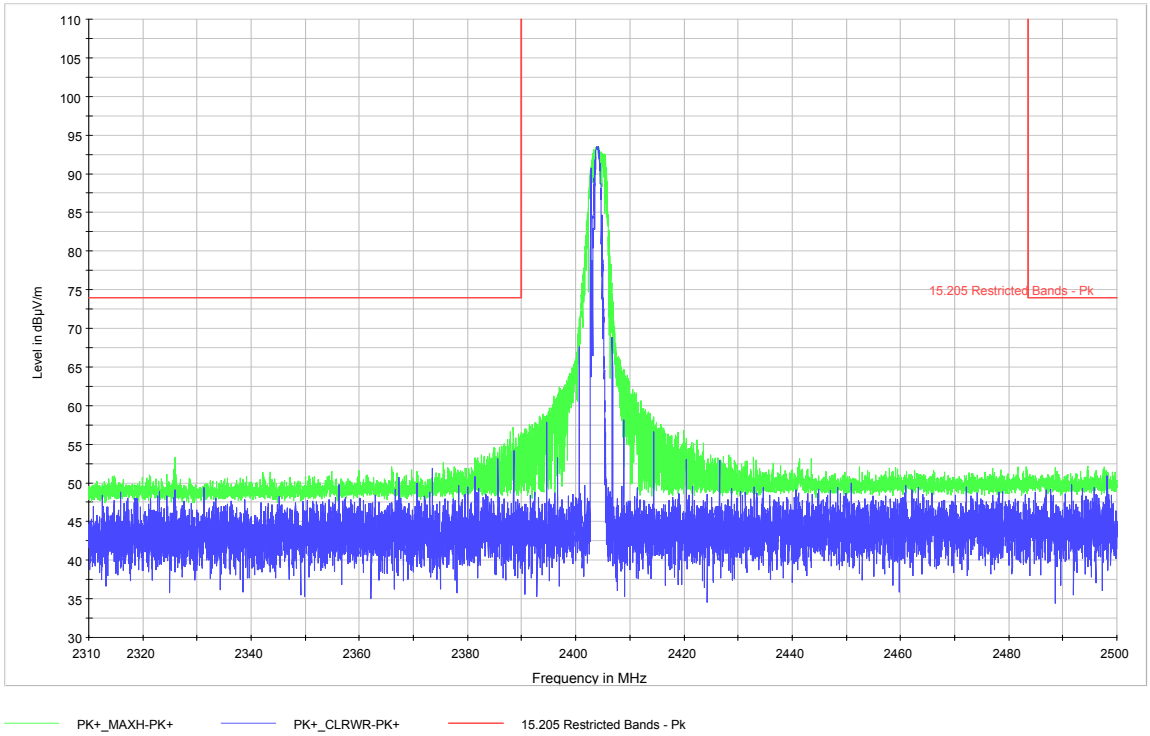

Figure 9-17 Radiated Restricted Band Edge (2404 MHz) Peak detector

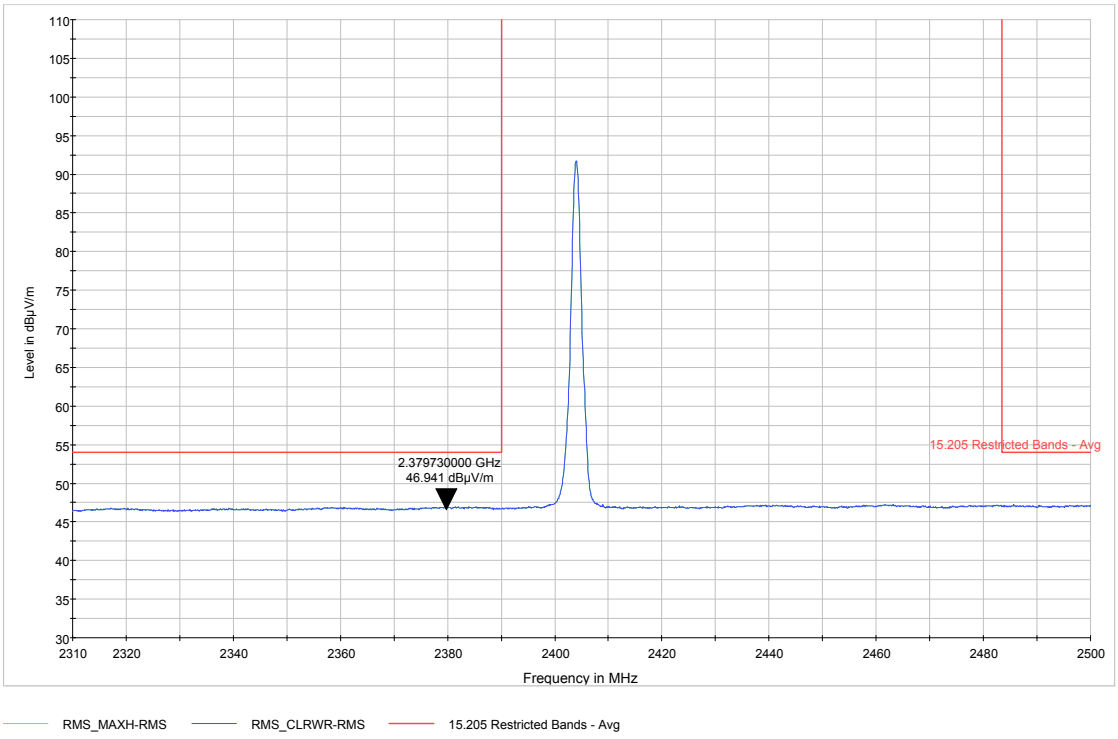

Figure 9-18 Radiated Restricted Band Edge (2404 MHz) Average detector

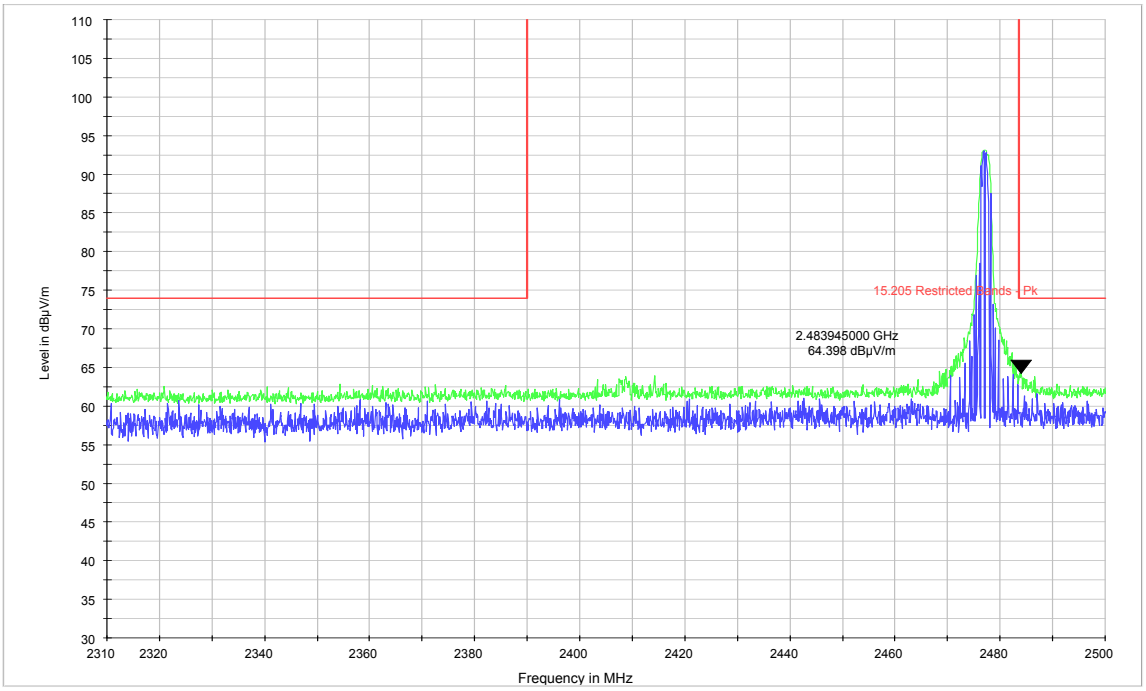

Figure 9-19 Radiated Restricted Band Edge (2477MHz) Peak detector

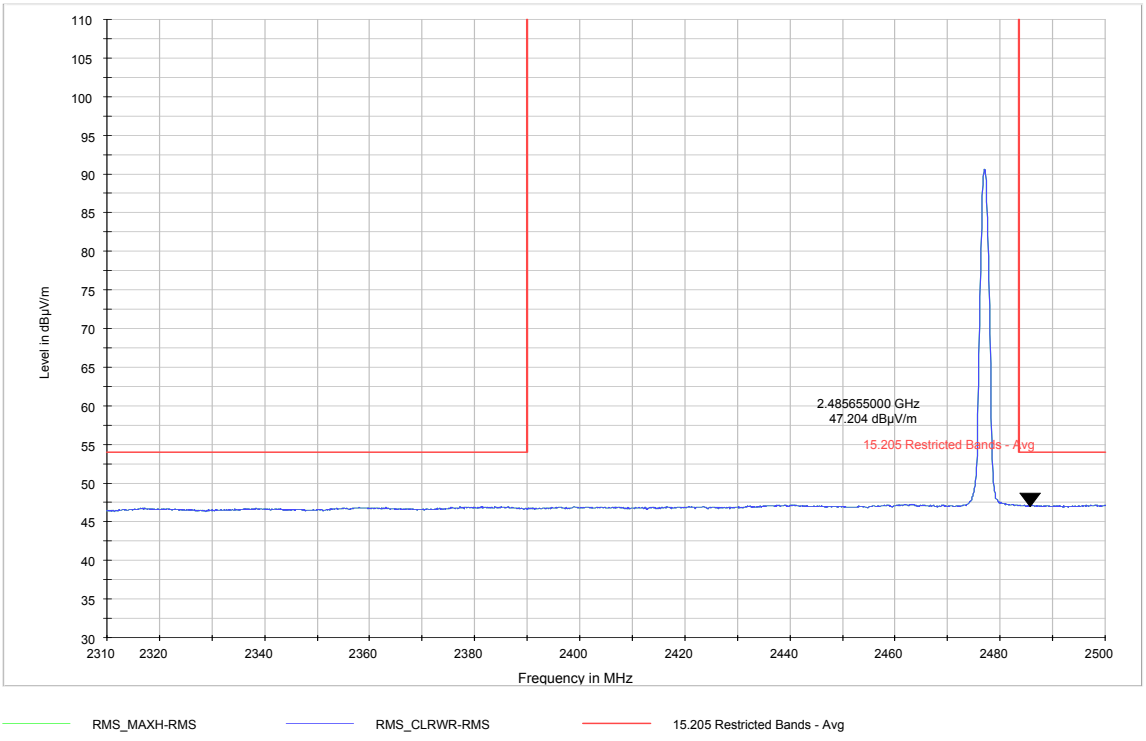

Figure 9-20 Radiated Restricted Band Edge (2477 MHz) Average detector

9.5 AC Line Conducted Emissions

9.5.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)

9.5.2 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

9.5.3 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

9.5.4 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)
0.15	35.8	32.31	66	56	N	-30.2	-23.69
26.52	31.49	26.13	60	50	N	-28.51	-23.87
25.7	31.71	25.58	60	50	L	-28.29	-24.42
25.76	30.84	24.51	60	50	N	-29.16	-25.49
27.09	30.04	24.39	60	50	L	-29.96	-25.61
28.16	27.52	21.96	60	50	L	-32.48	-28.04
0.32	30.26	21.64	60	50	N	-29.54	-28.16
0.32	29.92	21.3	60	50	L	-29.87	-28.49
27.84	26.75	20.82	60	50	N	-33.25	-29.18
0.19	36.93	22.71	64	54	L	-27.09	-31.31

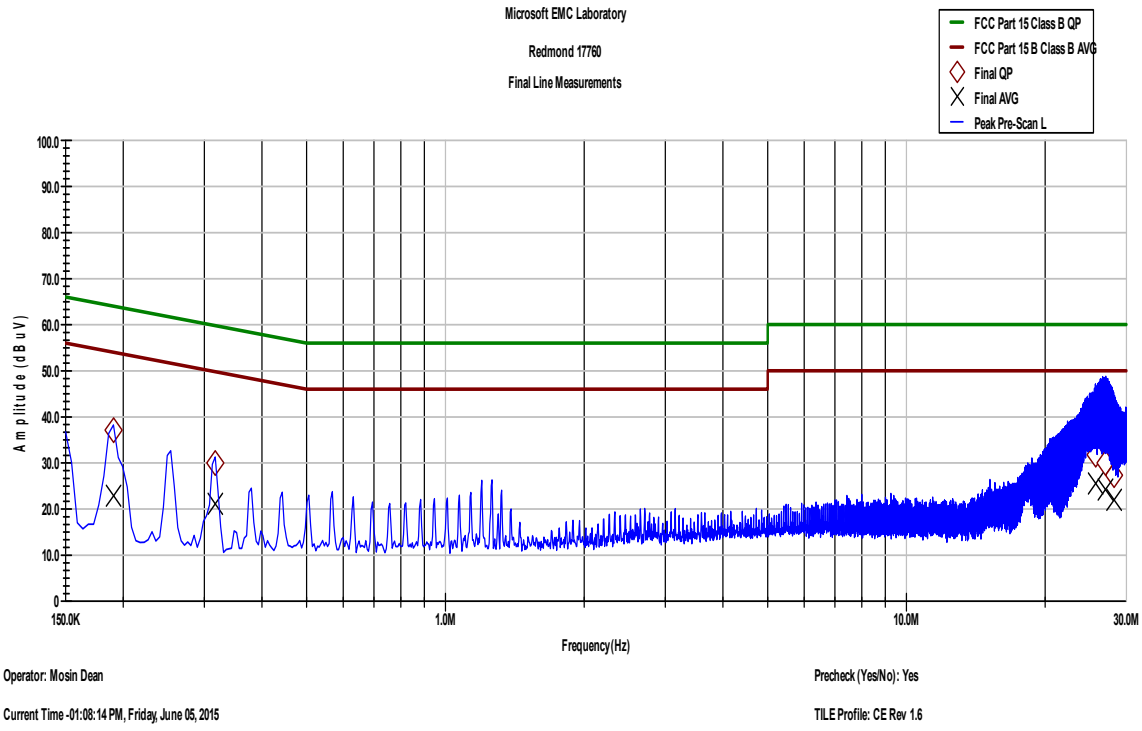

Figure 9-21 AC Conducted Emissions - Line (150 kHz-30MHz)

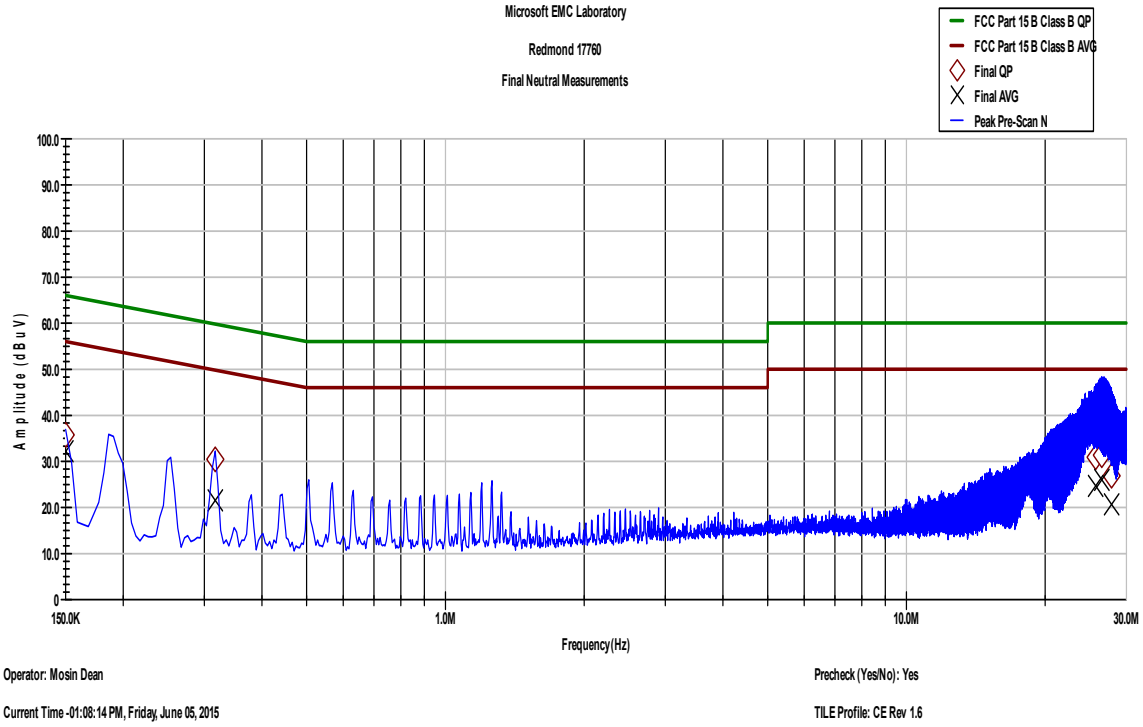

Figure 9-22 AC Conducted Emissions - Neutral (150 kHz-30MHz)

Microsoft

End of Report