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Emissions
Test Report

EUT Name: FB40-ND1

Model No.: FB40-ND1

CFR 47 Part 15.407 2018 and RSS 247: 2017

Prepared for:

Continental Automotive
21440 West Lake Cook Road
Deer Park, Illinois 60010, USA

Prepared by:

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Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	10/22/2018	Original Document	DA
1	11/30/2018	Updated per comments from TCB review	DA
2	12/5/2018	Updated per comments from final TCB review	DA

Note: Latest revision report will replace all previous reports.

Statement of Compliance

Manufacturer:	Continental Automotive 21440 West Lake Cook Road Deer Park, Illinois 60010, USA
Requester / Applicant:	Continental Automotive
Name of Equipment:	FB40-ND1
Model No.	FB40-ND1
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.407 2018 and RSS 247: 2017
Test Dates:	September 28, 2018 to October 19, 2018

Guidance Documents:

Emissions: ANSI C63.10-2013, KDB 789033 D02 General UNII Test Procedures New Rules v02r01

Test Methods:

Emissions: ANSI C63.10-2013, KDB 789033 D02 General UNII Test Procedures New Rules v02r01

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Douglas Antioco		Josie Sabado	
Test Engineer	Date December 5, 2018	A2LA Signatory	Date December 5, 2018

Testing Cert #3331.02 **US1131** **2932M**

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.407 2018 and RSS 247: 2017 based on the results of testing performed on September 28, 2018 to October 19, 2018 on the FB40-ND1 Model FB40-ND1 manufactured by Continental Automotive. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report. The 5150-5250 MHz and 5725-5850 MHz frequency bands are covered in this document.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.4	Worse Case (Measured)	Result
Maximum Output Power	CFR47 15.407 (a)	11.3 dBm (802.11n HT20)	**Complied**
Maximum Output Power	RSS 247 Sect.6.2.1.1	15.1 MHz (802.11n HT20)	**Complied**
DTS Bandwidth (6dB)	CFR47 15.407 (a) RSS-247 5.2(a)	-0.2 dBm (802.11n HT20)	**Complied**
Peak Power Spectral Density	CFR47 15.407 (a)	0.5 dBm (802.11n HT20)	**Complied**
Peak Power Spectral Density	RSS 247 Sect.6.2	2 dB margin @ 5150MHz (802.11n HT40)	**Complied**
Out of Band Emissions: U-NII-1 Restricted Band Edge	CFR47 15.407 (a)	See Plots in Section 4.5.5	**Complied**
Out of Band Emissions: U-NII-3 Unrestricted Band Edge	*CFR47 15.407 (b)(4)(i)* *RSS 247 Sect.6.2.1.2*	2.1 dB Margin (802.11n HT20)	**Complied**
Transmitter Spurious Emissions	CFR47 15.209, CFR47 15.407 (b) RSS-GEN Sect.8.9, RSS-247 Sect. 6.2.1.2	11.3 dBm (802.11n HT20)	**Complied**
AC Power Conducted Emission	CFR47 15.207 RSS-GEN Sect.8.8	N/A	**N/A (See Note 2)**
Frequency Stability	CFR47 15.407 (g) RSS-GEN Sect. 6.11	N/A (Manufacturer Declaration)	**Complied**

Note: 1. This test report covers 5150-5250MHz and 5725-5850 MHz bands.
2. EUT is DC powered.

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (US1131). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2017 (Lab Code Testing Cert #3331.02). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated biennially.

2.1.3 Canada – Industry Canada

TUV Rheinland of North America at the 1279 Quarry Ln, Pleasanton, CA 94566 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0261

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, USA.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 and 5 meters. The site is listed with the FCC and accredited by A2LA (Lab Code Testing Cert #3331.02). The 3/5-meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 meter and 5 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty

Per CISPR 16-4-2	**U_{lab}**	**U_{cispr}**
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 dB
1 – 6 GHz	2.12 dB	4.25 dB
6 – 18 GHz	2.47 dB	4.93 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.09 dB	2.18 dB
Disturbance Power		
30 MHz– 300 MHz	3.92 dB	4.3 dB

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

3 Product Information

3.1 Product Description

The Model FB40-ND1, FB40-ND1, is an Embedded communication device for automotive.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of an EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing.

3.3 Unique Antenna Connector

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. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.3.1 Results

The FB40-ND1 has a PCB type F dual band antenna that has maximum gain of 0.7 dBi for 5150-5250MHz and 1.9 dBi for 5725-5850MHz. This antenna is not easily accessible to the end user.

Refer to Table 12 for additional antenna information.

3.4 Transmit Power Control

According to manufacturer's declaration, the EUT employs Transmit Power Control in order to have the capability to operate at least 3 dB below the maximum permitted EIRP of 30mW per RSS-247 Section 6.2.1.1.

During normal operation, the EUT prioritizes operation of the highest data rates which have the lowest power setting as shown in section 3.7.1 of this report. If signal quality is not ideal, the EUT then uses the lower data rates which have higher power settings.

This test report covers the mode which has highest power levels as determined in section 3.7.1.

3.5 Discontinuation of Transmission

According to manufacturer's declaration, the EUT automatically discontinues transmission in case of either absence of information to transmit or operational failure per FCC §15.407 (c).

3.6 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of an EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing.

3.7 Worst Case Test Modes

The worst case chain was determined by using a gated RMS power meter as described by ANSI C63.10-2013 Section 12.3.3.2.

3.7.1 Worse Case Modulation

The worst case modulation was measured using a gated RMS power meter per ANSI C63.10-2013 section 12.3.3.2 Method PM-G, results are not corrected for any cable attenuation. The power settings used are the maximum levels provided from the manufacturer.

Mode	Modulation	Data Rate	Power Setting	Power Measured (dBm)
802.11a NoHT	BPSK	6	12	11.3
	BPSK	9	12	11.4
	QPSK	12	12	11.4
	QPSK	18	12	11.5
	16-QAM	24	12	11.9
	16-QAM	36	12	11.8
	64-QAM	48	11	10.9
	64-QAM	54	10	9.9
802.11n HT20	BPSK (MCS0)	6.5	12	11.3
	QPSK (MCS1)	13	12	11.2
	QPSK (MCS2)	19.5	12	11.4
	16-QAM (MCS3)	26	12	12.0
	16-QAM (MCS4)	39	12	12.0
	64-QAM (MCS5)	54	11	11.0
	64-QAM (MCS6)	58.5	11	11.0
	64-QAM (MCS7)	65	10	10.0
802.11ac VHT20	BPSK (MCS0)	6.5	12	11.5
	QPSK (MCS1)	13	12	11.3
	QPSK (MCS2)	19.5	12	11.4
	16-QAM (MCS3)	26	12	12.0
	16-QAM (MCS4)	39	12	12.0
	64-QAM (MCS5)	54	11	11.0

	64-QAM (MCS6)	58.5	11	11.1
	64-QAM (MCS7)	65	10	10.0
	256-QAM (MCS8)	78	7	7.0
802.11n HT40+	BPSK (MCS0)	13.5	12	12.0
	QPSK (MCS1)	27	12	12.0
	QPSK (MCS2)	40.5	12	12.0
	16-QAM (MCS3)	54	11	11.1
	16-QAM (MCS4)	81	11	11.1
	64-QAM (MCS5)	108	11	11.2
	64-QAM (MCS6)	121.5	10	10.1
	64-QAM (MCS7)	135	10	10.1
802.11ac VHT40	BPSK (MCS0)	13.5	12	12.0
	QPSK (MCS1)	27	12	12.0
	QPSK (MCS2)	40.5	12	12.0
	16-QAM (MCS3)	54	11	11.2
	16-QAM (MCS4)	81	11	11.2
	64-QAM (MCS5)	108	11	11.2
	64-QAM (MCS6)	121.5	10	10.2
	64-QAM (MCS7)	135	10	10.2
	256-QAM (MCS8)	162	8	8.2
	256-QAM (MCS9)	180	8	8.2
802.11ac VHT80	BPSK (MCS0)	29.3	11	10.8
	QPSK (MCS1)	58.5	11	10.9
	QPSK (MCS2)	87.8	11	10.9
	16-QAM (MCS3)	117	10	10.2
	16-QAM (MCS4)	175.5	10	10.2
	64-QAM (MCS5)	234	10	10.2
	64-QAM (MCS6)	263.3	9	9.3

	64-QAM (MCS7)	292.5	9	9.4
	256-QAM (MCS8)	351	7	7.2
	256-QAM (MCS9)	390	6	7.2

802.11n MCS3, 802.11n HT40+ MCS0, 802.11ac VHT80 MCS1 modes were used for further measurements. For UNII-3 Band, 802.11n/ac HT20/VHT20 mode at MCS3 uses a power setting of 11 instead of 12, so MCS2 was used instead.

4 Emissions

Testing was performed in accordance with CFR 47 Part 15.407: 2016 and RSS 247: 2017. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in section 8 of the standard were used.

4.1 Output Power

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

4.1.1 Limit(s)

The maximum output power and harmonics shall not exceed CFR47 Part 15.407 (a):2016 and RSS 247 Sect. 6.2.1 and 5.4.

For FCC: The EUT is evaluated an outdoor access point

For ISED: The EUT is evaluated as an OEM device installed in vehicles

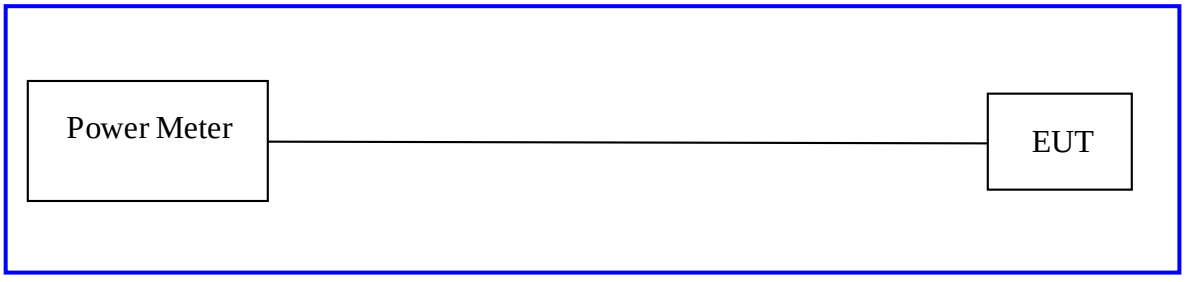
The maximum allowed transmit powers are

Frequency (MHz)	*§15.407*	*RSS-247*
5150-5250	*30 dBm (Conducted)* *21 dBm EIRP (Elevations above 30° from horizon)*	*30 mW or* *1.76 + 10 log$_{10}$B, dBm (EIRP)*
5725-5850	*30 dBm (Conducted)*	*30 dBm (Conducted)*

4.1.2 Test Method

The ANSI C63.10-2013 Section 12.3.2.7 Method SA-3A (alternative) conducted method was used to measure the channel power output. The preliminary investigation was performed at different data rate/ chain to determine the highest power output for each mode (Section 3.5 of this report). The worst findings were conducted on the low, middle and high channels, where applicable, in each operating range per CFR47 Part 15.407(a) and RSS 247 Sect. 6.2.1.1; 5150 MHz to 5250 MHz. The worst mode results indicated below.

4.1.3 Test Setup:



4.1.4 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.1.4.1 FCC Power Measurements

Table 2: FCC RF Output Powers

UNII-1 (5150-5250MHz)								
Mode	Channel	Bandwidth (MHz)	Frequency (MHz)	Power Setting	Total Power (RMS)	Limit (dBm)*	Margin (dB)	Result
802.11n HT20 MCS3	36	20	5180	12	11.0	30	19.0	Pass
	44	20	5220	12	11.2	30	18.8	Pass
	48	20	5240	12	11.3	30	18.7	Pass
802.11n HT40+ MCS0	38	40	5190	12	11.1	30	18.9	Pass
	46	40	5230	12	11.3	30	18.7	Pass
802.11ac VHT80 MCS1	42	80	5210	11	10.3	30	19.7	Pass
UNII-3 (5725-5850MHz)								
Mode	Channel	Bandwidth (MHz)	Frequency (MHz)	Power Setting	Total Power (RMS)	Limit (dBm)	Margin (dB)	Result
802.11n HT20 MCS2	149	20	5745	12	10.8	30	19.2	Pass
	157	20	5785	12	10.9	30	19.1	Pass
	165	20	5825	12	10.9	30	19.1	Pass
802.11n HT40+ MCS0	151	40	5755	12	11.3	30	18.7	Pass
	159	40	5795	12	11.3	30	18.7	Pass
802.11ac VHT80 MCS1	155	80	5775	11	10.4	30	19.6	Pass

*UNII-1 limit is also 21 dBm EIRP for Elevations above 30° from horizon

4.1.4.2 ISED Power Measurements

Table 3: ISED RF Output Powers

UNII-1 (5150-5250MHz)										
Mode	Channel	Bandwidth (MHz)	Frequency (MHz)	Power Setting	Total Power (RMS)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
802.11n HT20 MCS3	36	20	5180	12	11.0	0.7	11.7	14.2	2.5	Pass
	44	20	5220	12	11.2	0.7	11.9	14.3	2.4	Pass
	48	20	5240	12	11.3	0.7	12.0	14.1	2.1	Pass
802.11n HT40+ MCS0	38	40	5190	12	11.1	0.7	11.8	14.8	3.0	Pass
	46	40	5230	12	11.3	0.7	12.0	14.8	2.8	Pass
802.11ac VHT80 MCS1	42	80	5210	11	10.3	0.7	11.0	14.8	3.8	Pass
UNII-3 (5725-5850MHz)										
Mode	Channel	Bandwidth (MHz)	Frequency (MHz)	Power Setting	Total Power (RMS)	Limit (dBm)		Margin (dB)		Result
802.11n HT20 MCS2	149	20	5745	12	10.8	30		19.2		Pass
	157	20	5785	12	10.9	30		19.1		Pass
	165	20	5825	12	10.9	30		19.1		Pass
802.11n HT40+ MCS0	151	40	5755	12	11.3	30		18.7		Pass
	159	40	5795	12	11.3	30		18.7		Pass
802.11ac VHT80 MCS1	155	80	5775	11	10.4	30		19.6		Pass

4.1.5 Measurement Plots

Note: Plots only reflect corrections for cable loss.

4.1.5.1 UNII-1

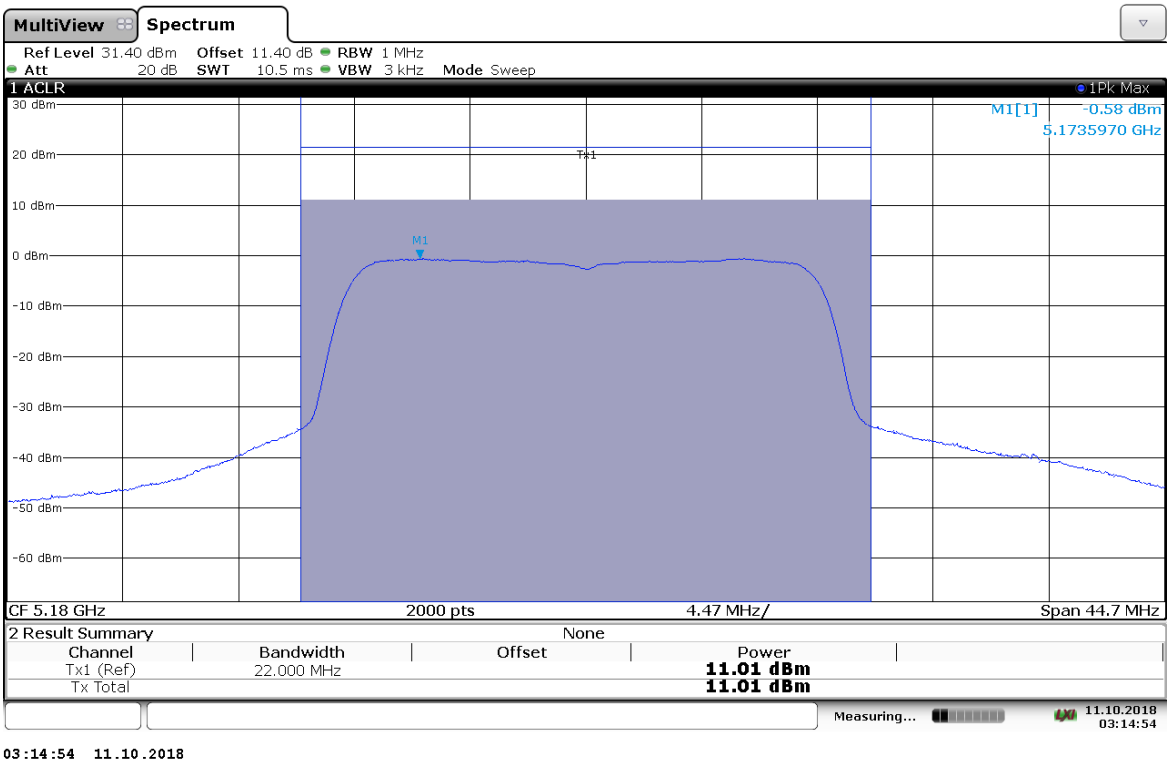


Figure 1: Power Spectral Density, Channel 36 802.11n HT20 MCS3

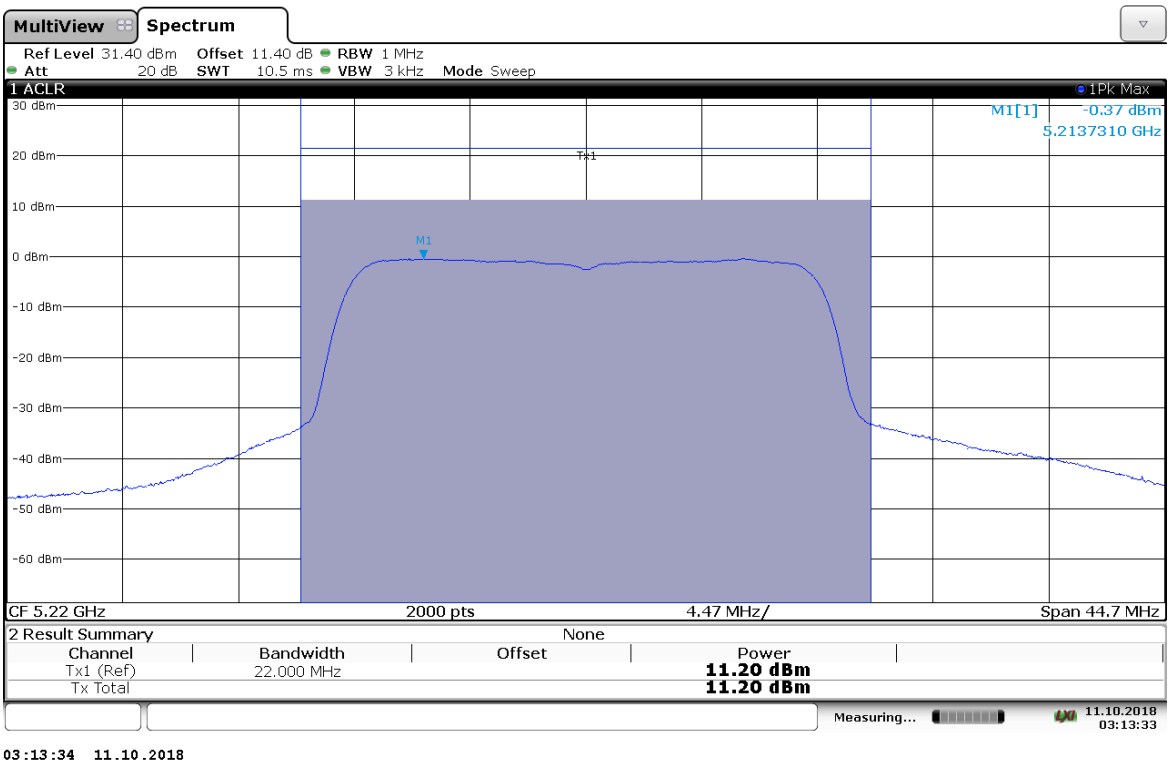


Figure 2: Power Spectral Density, Channel 44 802.11n HT20 MCS3

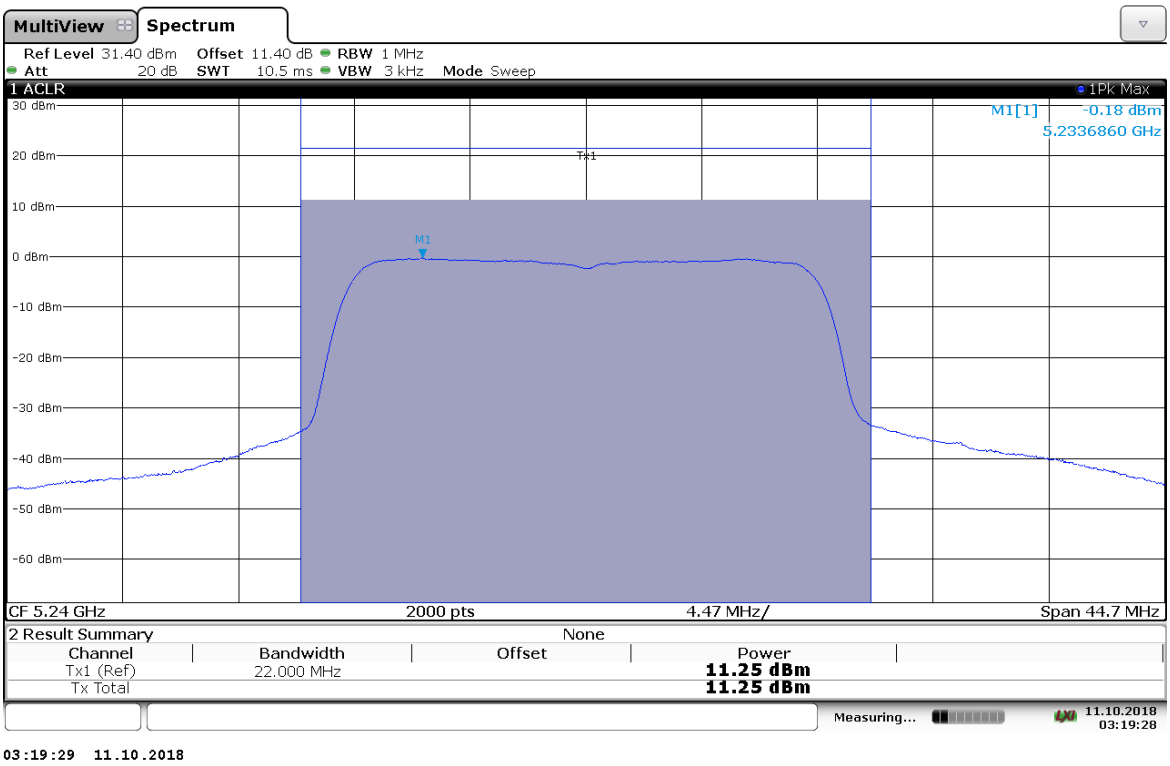


Figure 3: Power Spectral Density, Channel 48 802.11n HT20 MCS3

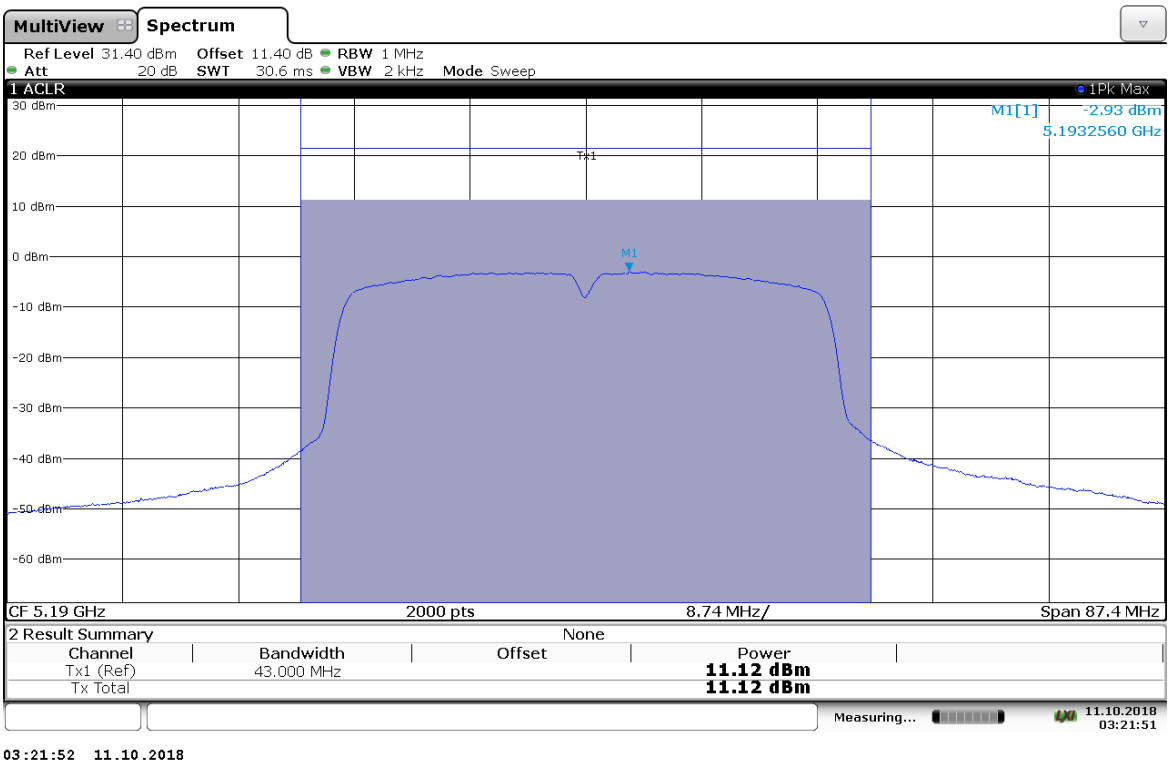


Figure 4: Power Spectral Density, Channel 38 802.11n HT40+ MCS0

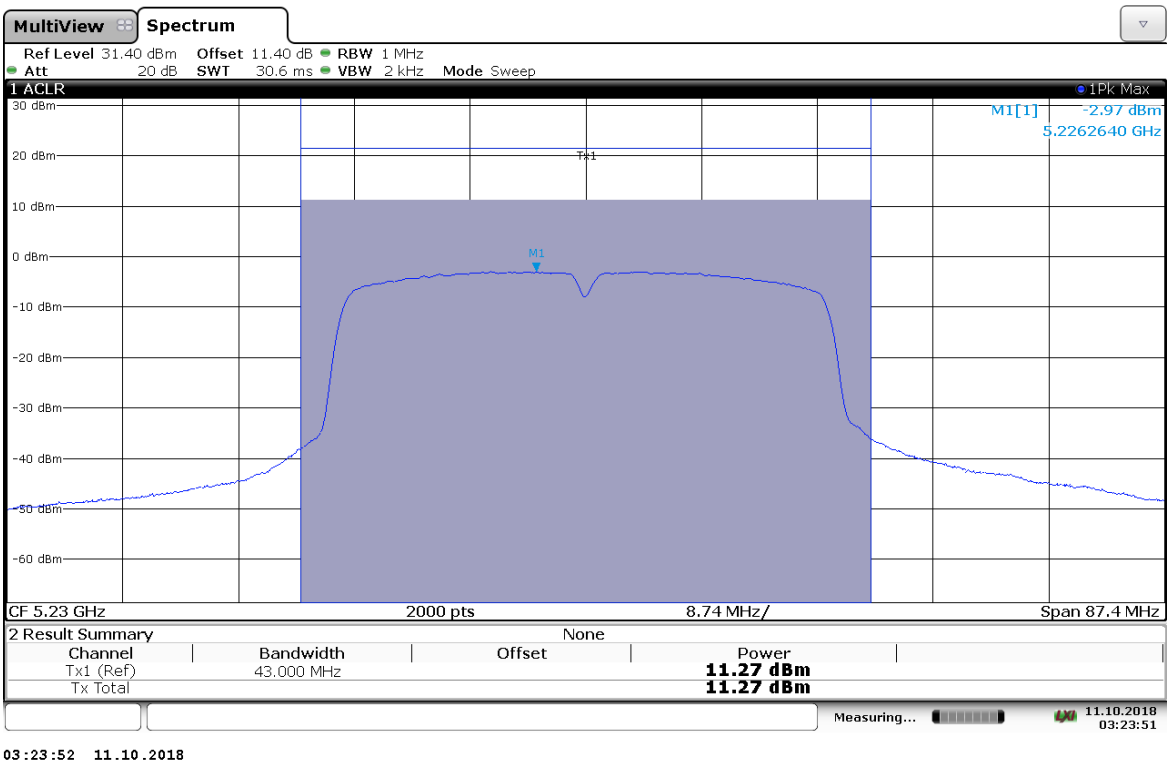


Figure 5: Power Spectral Density, Channel 46 802.11n HT40+ MCS0

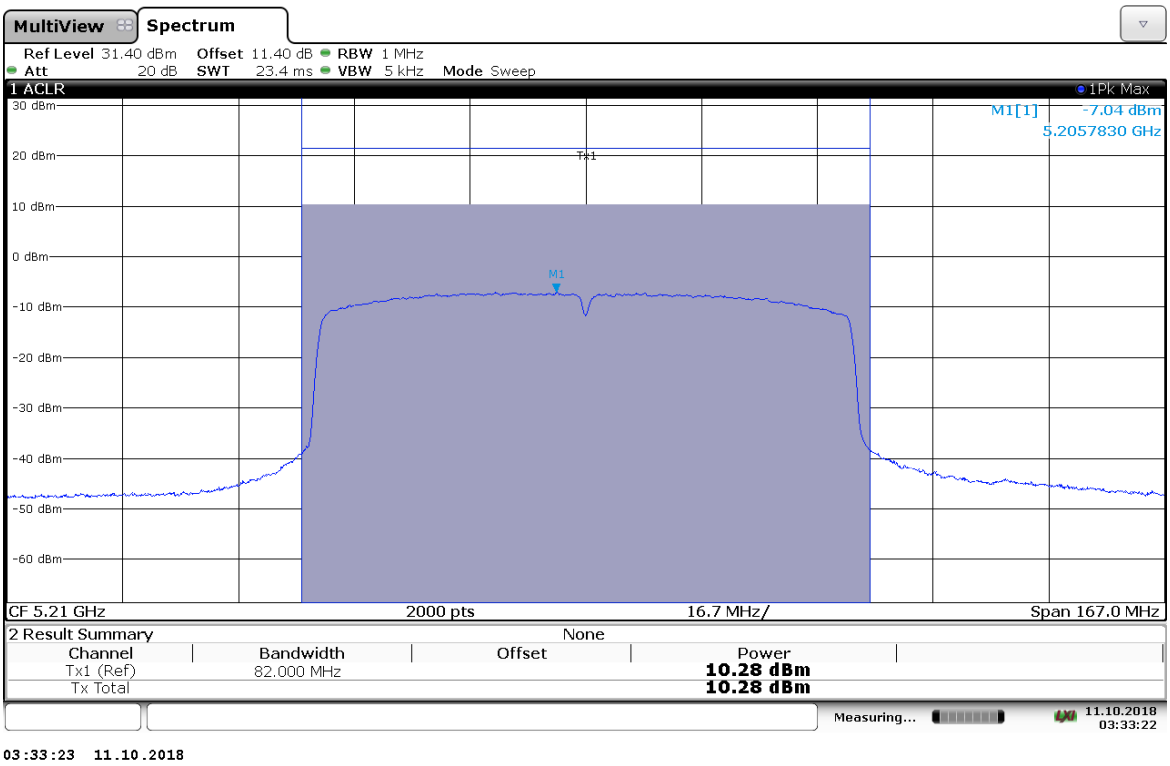


Figure 6: Power Spectral Density, Channel 42 802.11ac VHT80 MCS1

4.1.5.2 UNII-3

Note: Plots only reflect corrections for cable loss.

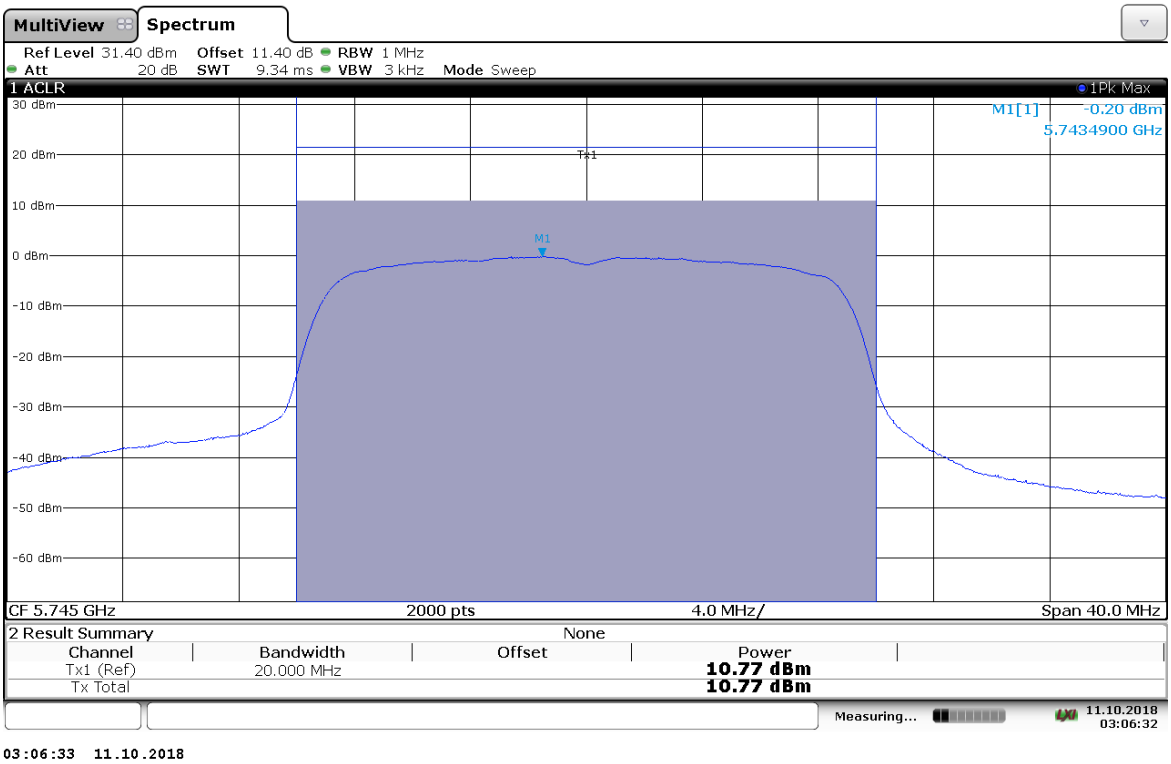


Figure 7: Power Spectral Density, Channel 149 802.11n HT20 MCS2

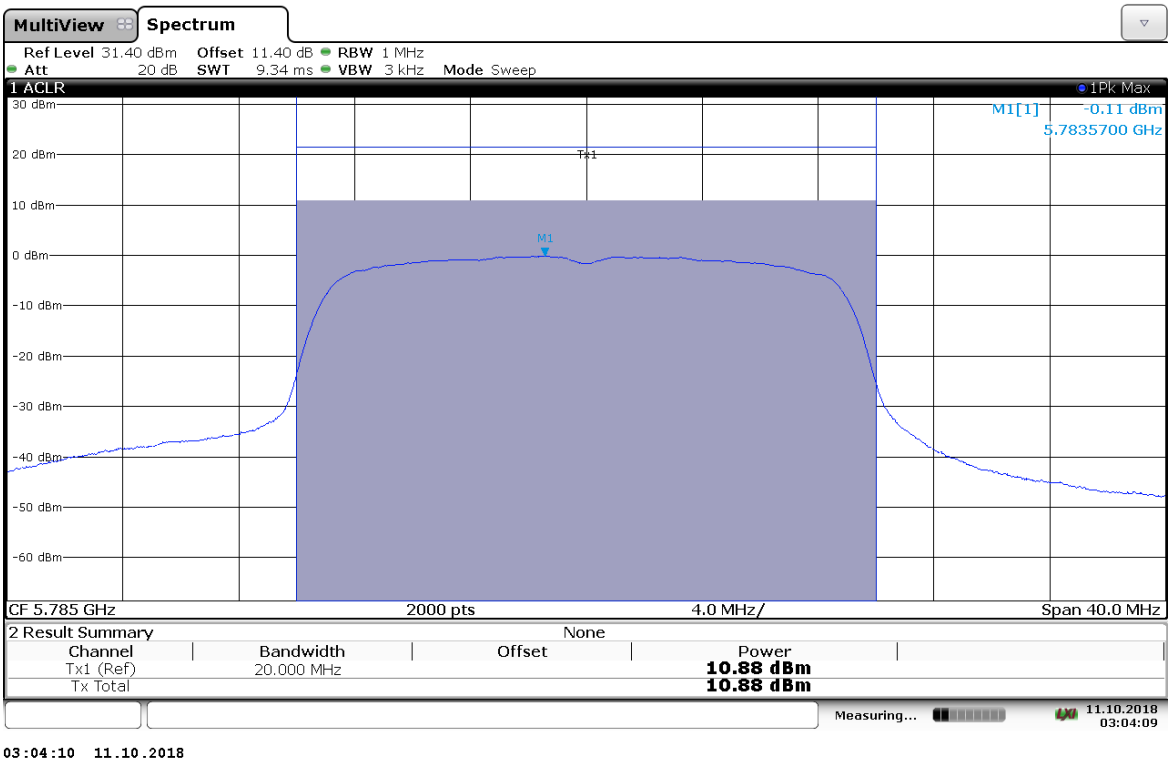


Figure 8: Power Spectral Density, Channel 157 802.11n HT20 MCS2

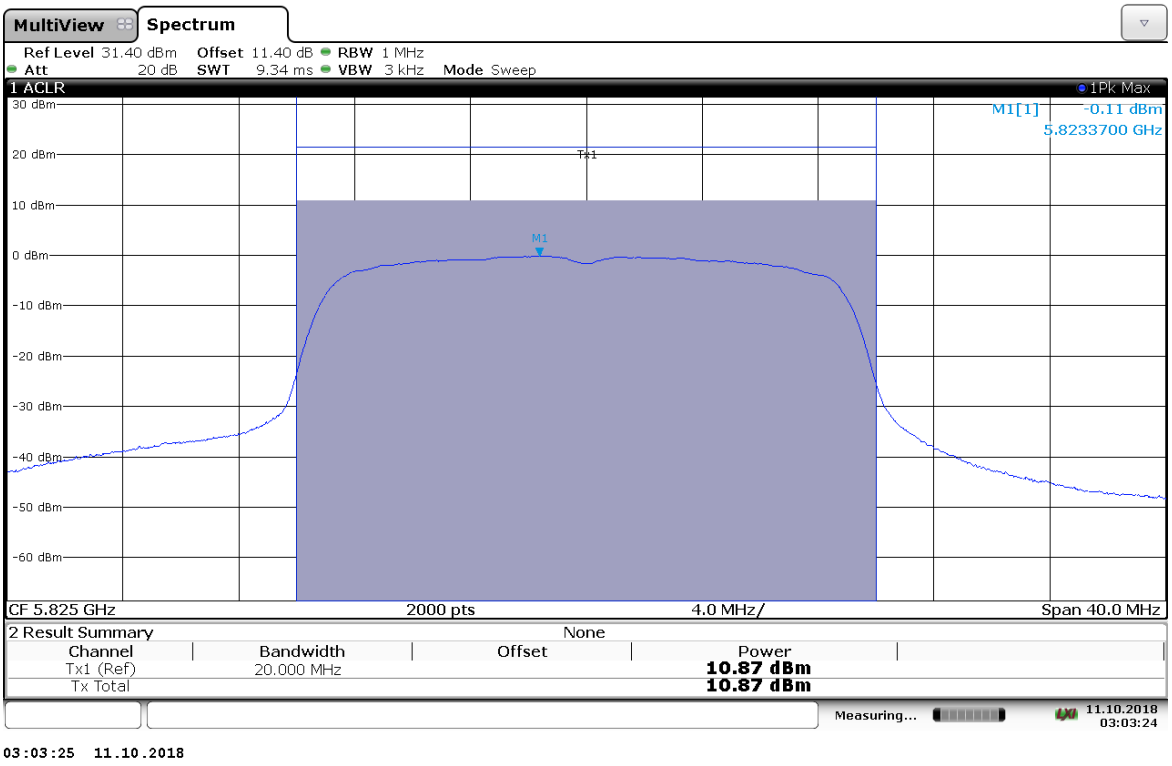


Figure 9: Power Spectral Density, Channel 165 802.11n HT20 MCS2

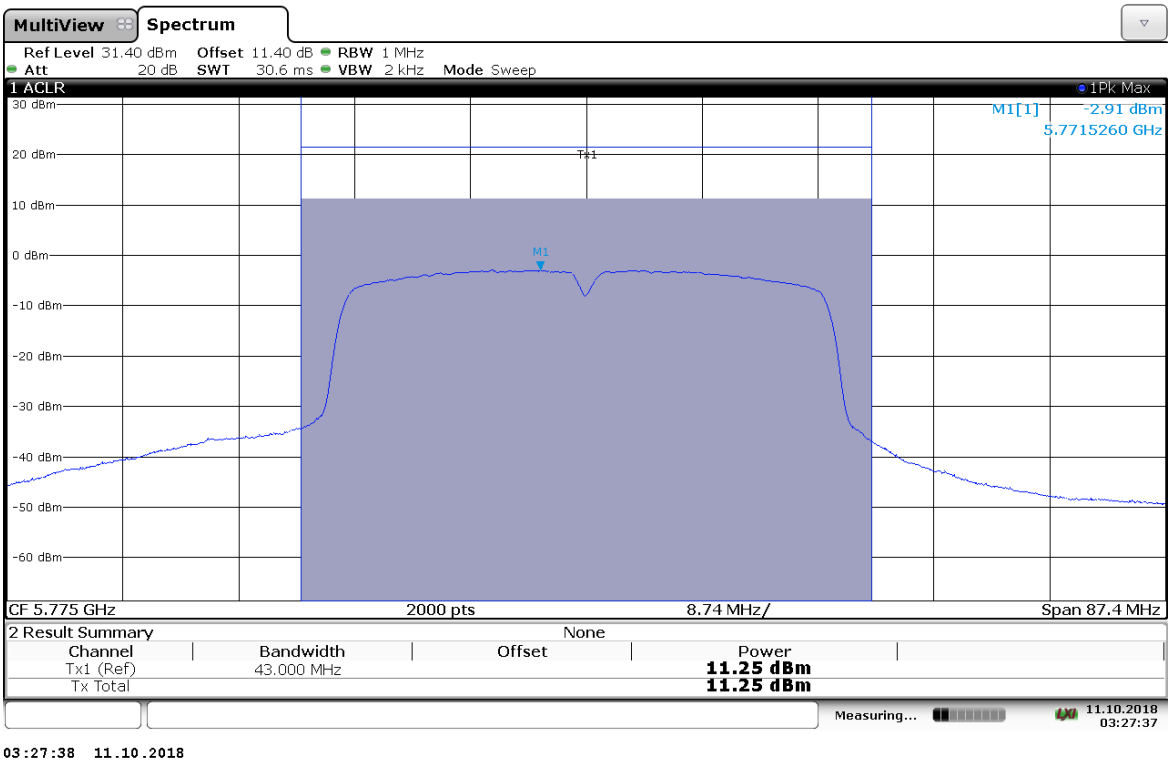


Figure 10: Power Spectral Density, Channel 151 802.11n HT40+ MCS0

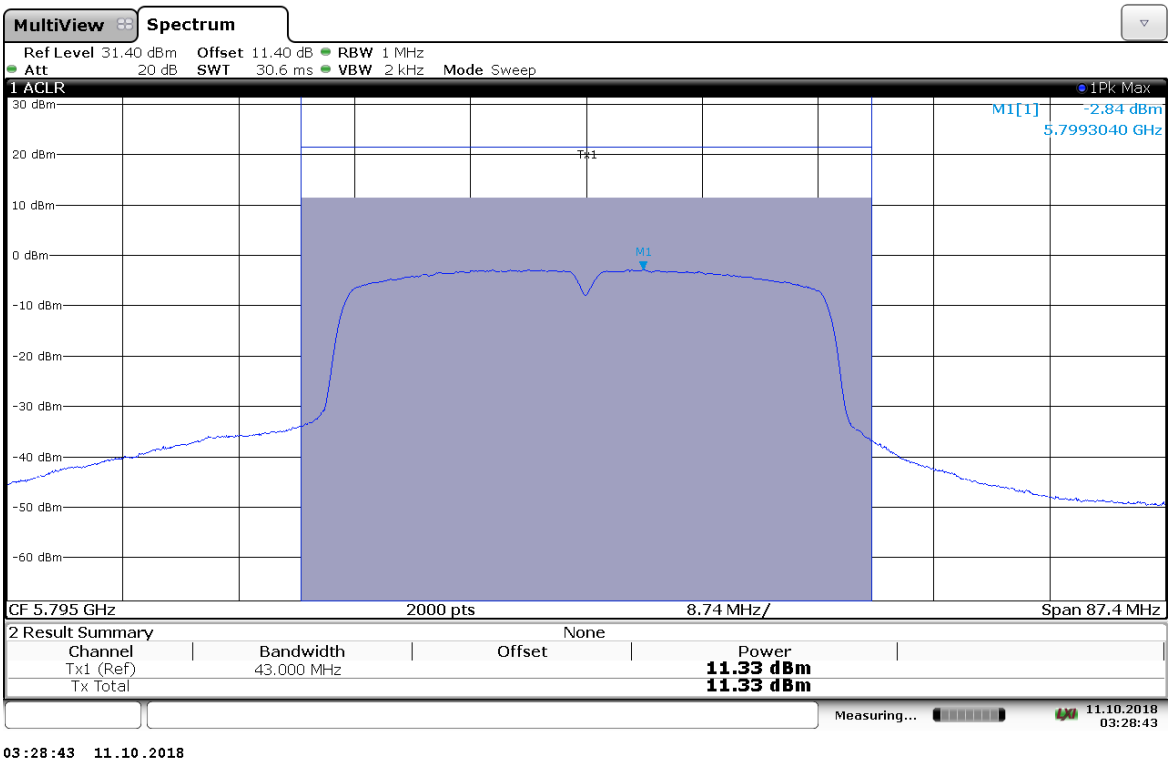


Figure 11: Power Spectral Density, Channel 159 802.11n HT40+ MCS0

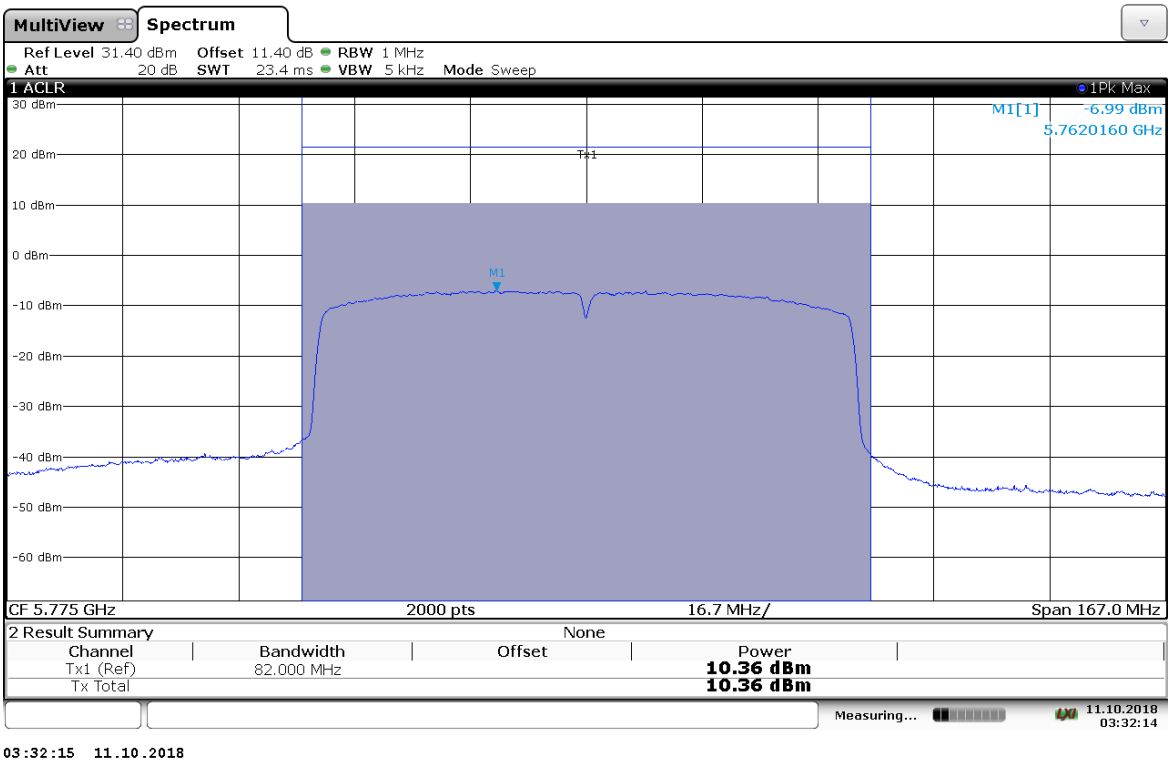
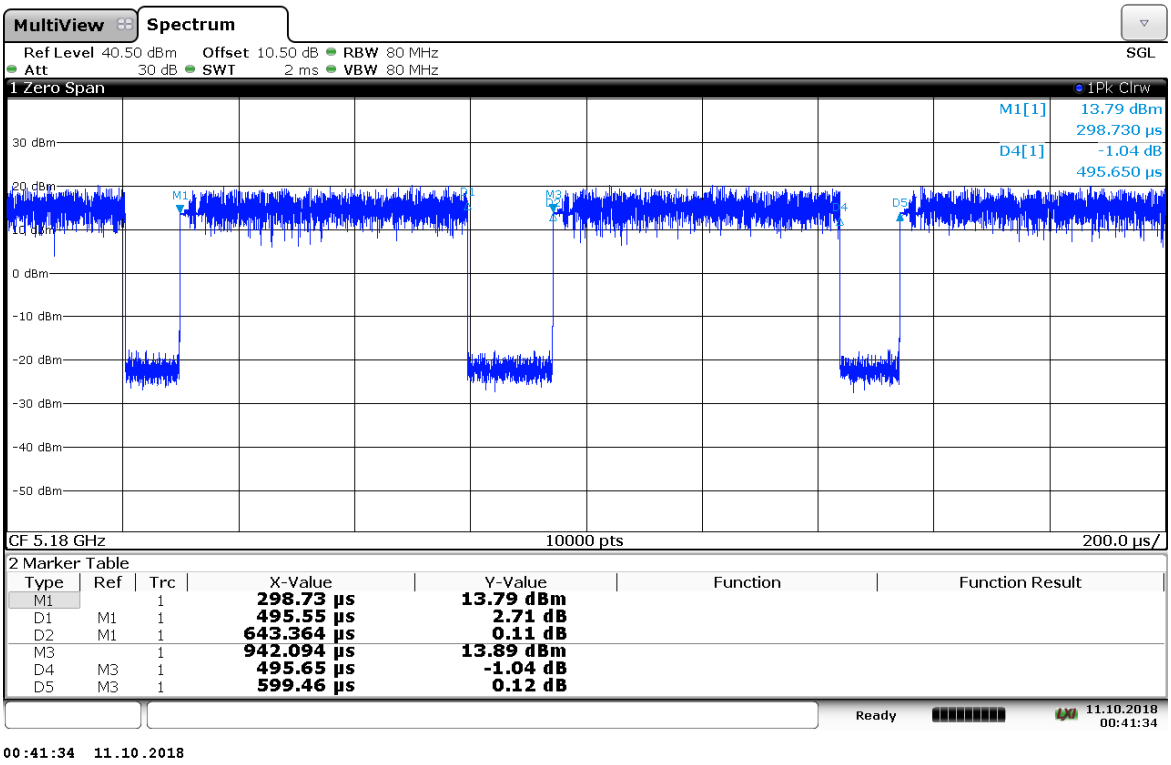


Figure 12: Power Spectral Density, Channel 155 802.11ac VHT80 MCS1

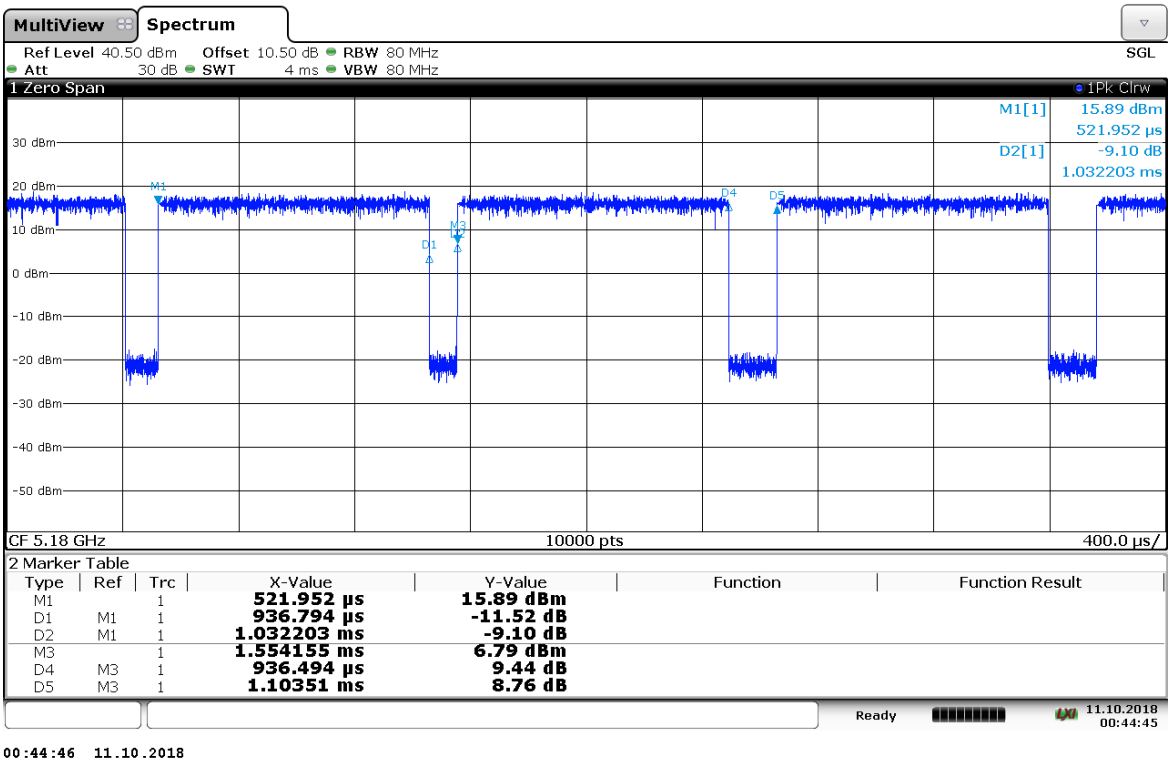
4.1.5.3 Transmission Duration

Mode	Measured Transmission Duration (us)	Video Bandwidth (KHz)
802.11n HT20 MCS3	495.7	3
802.11n HT40+ MCS0	936.8	2
802.11ac VHT80 MCS1	240.1	5

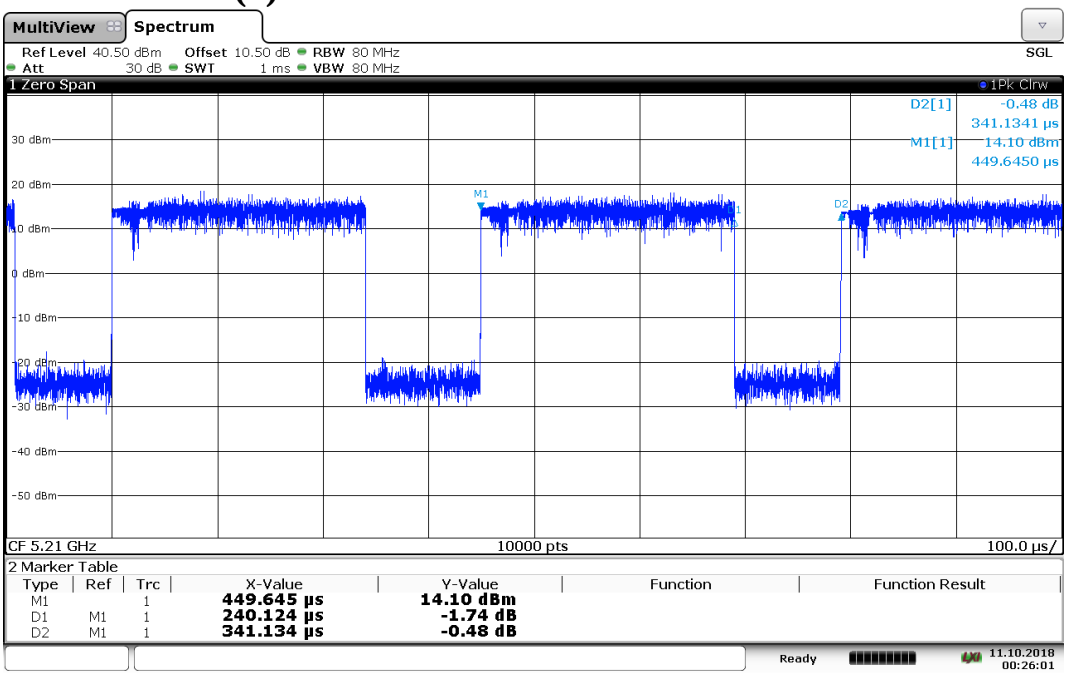
HT20 Mode



HT40 Mode

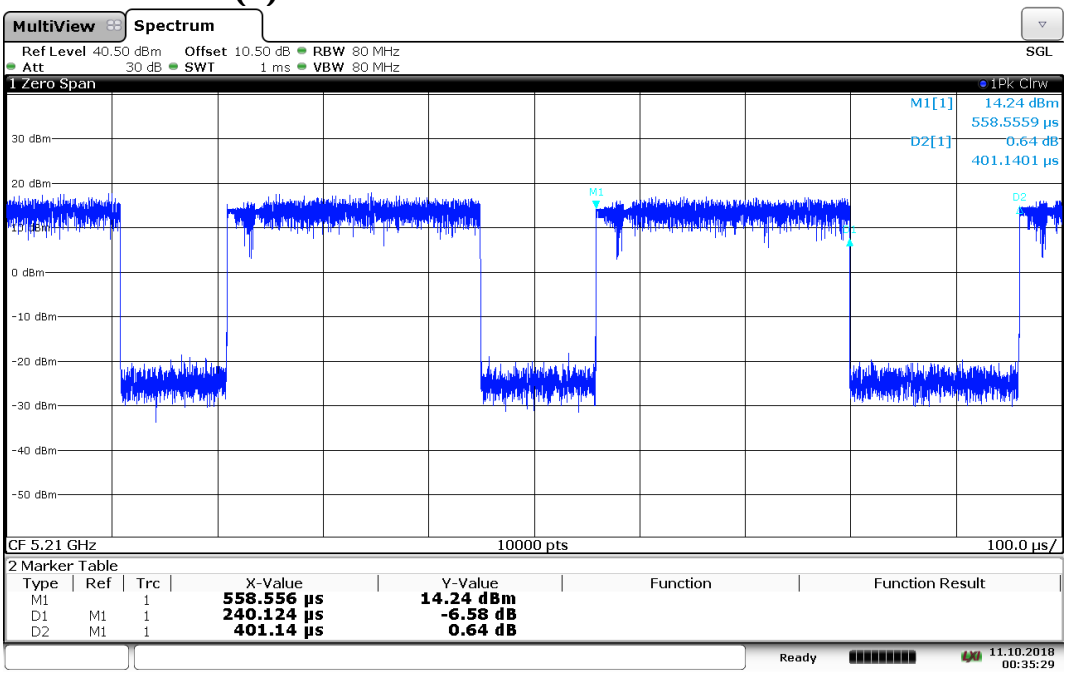

MultiView
Spectrum
Ref Level 40.50 dBm Offset 10.50 dB RBW 80 MHz
Att 30 dB SWT 4 ms VBW 80 MHz
SGL
1 Zero Span
1Pk Clrw
M1[1] 15.89 dBm
521.952 µs
D2[1] -9.10 dB
1.032203 ms
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
CF 5.18 GHz
10000 pts
400.0 µs/
2 Marker Table
Type Ref Trc X-Value Y-Value Function Function Result
M1 1 521.952 µs 15.89 dBm
D1 M1 1 936.794 µs -11.52 dB
D2 M1 1 1.032203 ms -9.10 dB
M3 1 1.554155 ms 6.79 dBm
D4 M3 1 936.494 µs 9.44 dB
D5 M3 1 1.10351 ms 8.76 dB
Ready
11.10.2018
00:44:45
00:44:46 11.10.2018

VHT80 Mode (1)



00:26:01 11.10.2018

VHT80 Mode (2)



00:35:30 11.10.2018

4.2 Occupied Bandwidth, Emission Bandwidth (26dB) and DTS Bandwidth (6dB)

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

The 6 dB bandwidth is defined the bandwidth of 6 dBr from highest transmitted level of the fundamental frequency.

4.2.1 Limit(s)

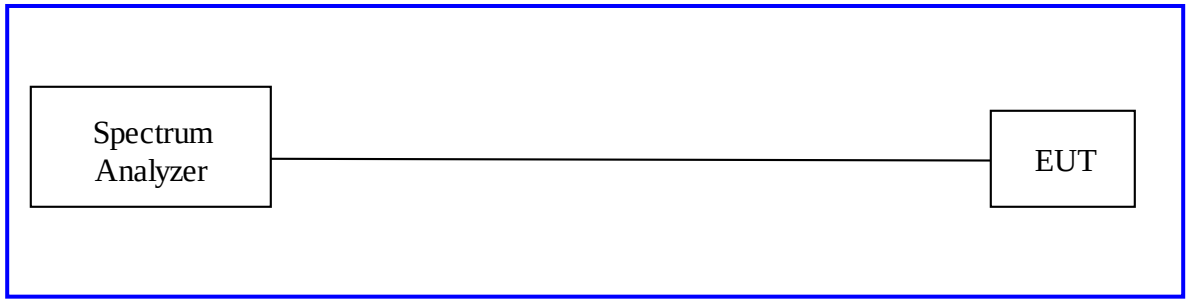
There is no restriction limits for the bandwidths in the U-NII-1 Band. The 99% bandwidth was used to determine the limit for maximum conducted output power per RSS-247 section 6.2.1.1 and to verify transmission in the U-NII-1 Band (5150-5250MHz).

For the U-NII-3 Band (5725-5850MHz) the minimum 6 dB bandwidth shall be at least 500 KHz per §15.407(e).

4.2.2 Test Method

The conducted method was used to measure the occupied bandwidth. The measurement was performed with modulation per CFR47 15.407(a) and RSS Gen Sect.6.6. For U-NII-1, the measurements were performed on 3 channels, where applicable, for the operating frequency range; 5150-5250 MHz to verify that the occupied bandwidth does not impede into the U-NII-2A band (5250-5350MHz) to ensure that DFS is not required. For occupied bandwidth measurements, procedures given by ANSI 63.10-2013 section 6.9.3 were used. For Emission Bandwidth (26dB), procedures given by ANSI 63.10-2013 section 12.4.1 were used. For DTS Bandwidth (6dB), procedures given by ANSI 63.10-2013 section 11.8.1 were used. The test plan for these measurements were based on guidance from ANSI 63.10-2013 sections 5.6.2.1 and 5.6.2.2.

4.2.3 Test Setup:



4.2.4 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Occupied and Emission Bandwidth – U-NII-1 Test Results

Mode	Channel	99% Bandwidth (MHz)			Emission Bandwidth (MHz)
		OBW	FL	FH	
802.11n HT20 MCS3	36	17.7	5171.1	5188.8	21.7
	44	17.8	5211.1	5228.8	21.6
	48	17.3	5231.3	5248.6	21.7
802.11n HT40+ MCS0	38	35.8	5172.1	5207.8	42.1
	46	35.8	5212.1	5247.8	41.2
802.11ac VHT80 MCS1	42	75.0	5172.4	5247.4	81.3

Table 5: Occupied and DTS Bandwidth– U-NII-3 Test Results

Mode	Channel	99% Bandwidth (MHz)	DTS Bandwidth (MHz)
802.11n HT20 MCS3	157	17.4	15.1
802.11n HT40+ MCS0	159	35.8	35.1
802.11ac VHT80 MCS1	155	75.0	75.1

4.2.4.1 Measurement Plots

4.2.4.1.1 UNII-1

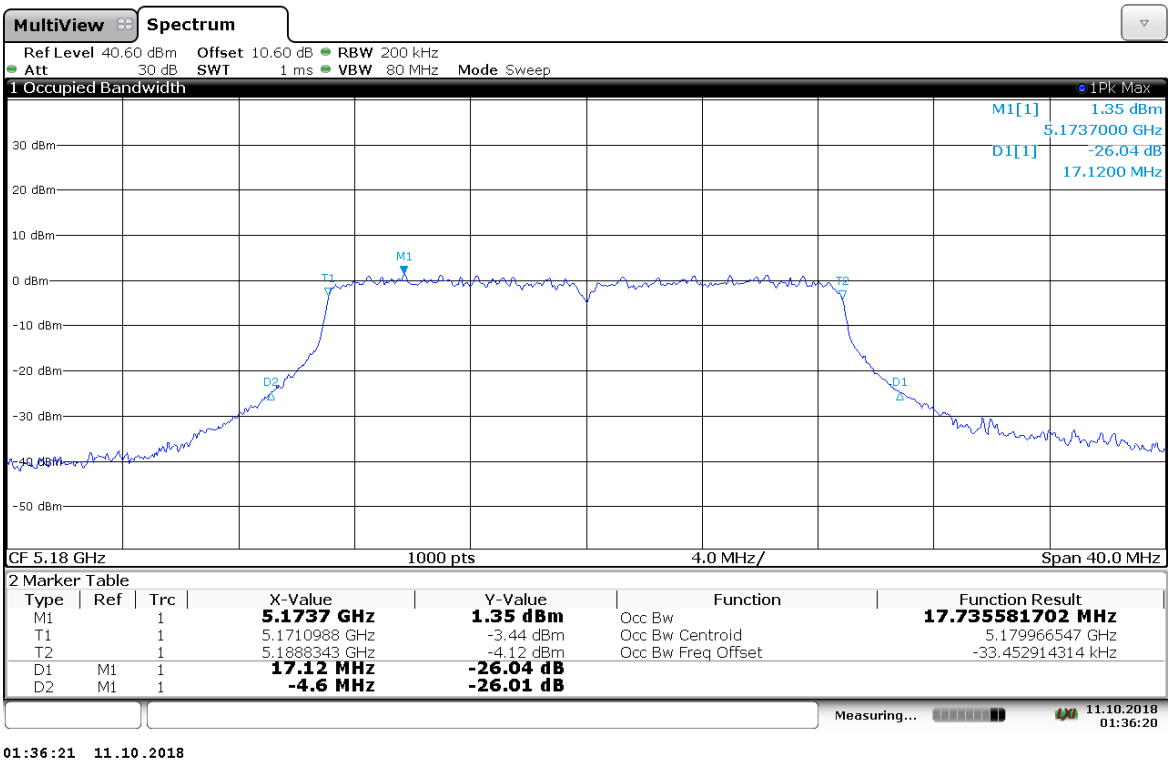


Figure 13: 99% Occupied and Emission Bandwidth, Channel 36 at 802.11n HT20 MCS3

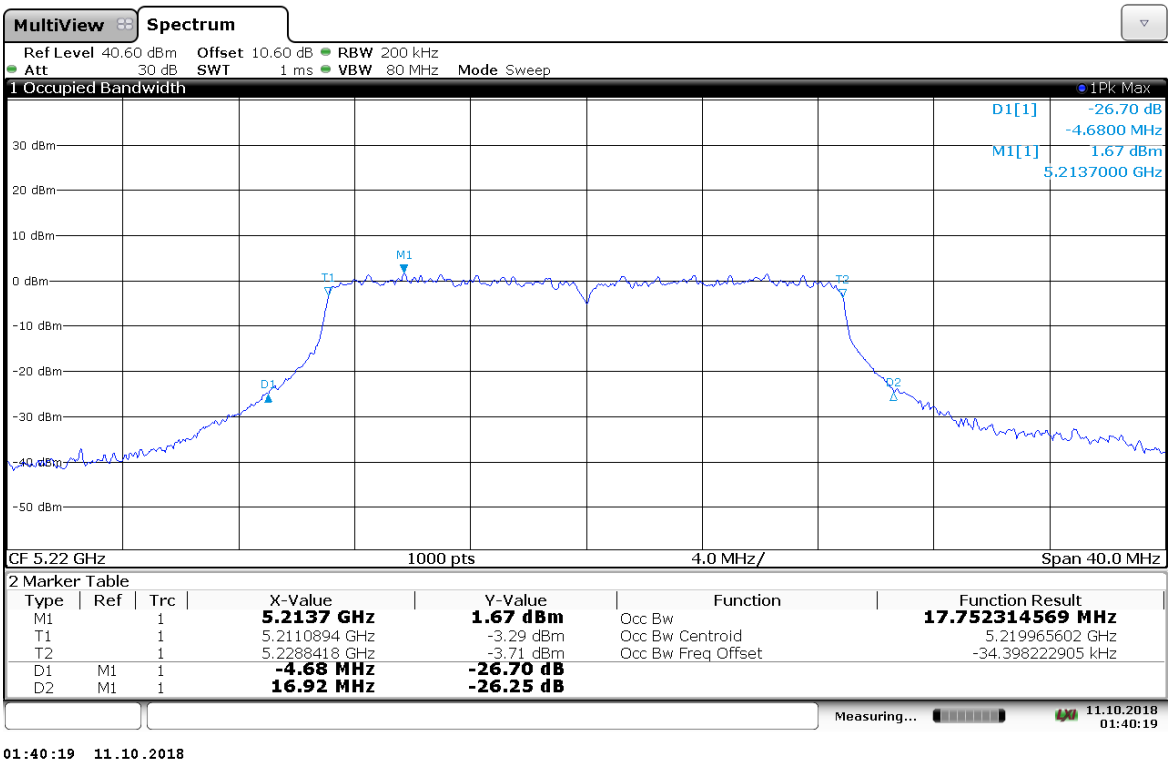


Figure 14: 99% Occupied and Emission Bandwidth, Channel 44 at 802.11n HT20 MCS3

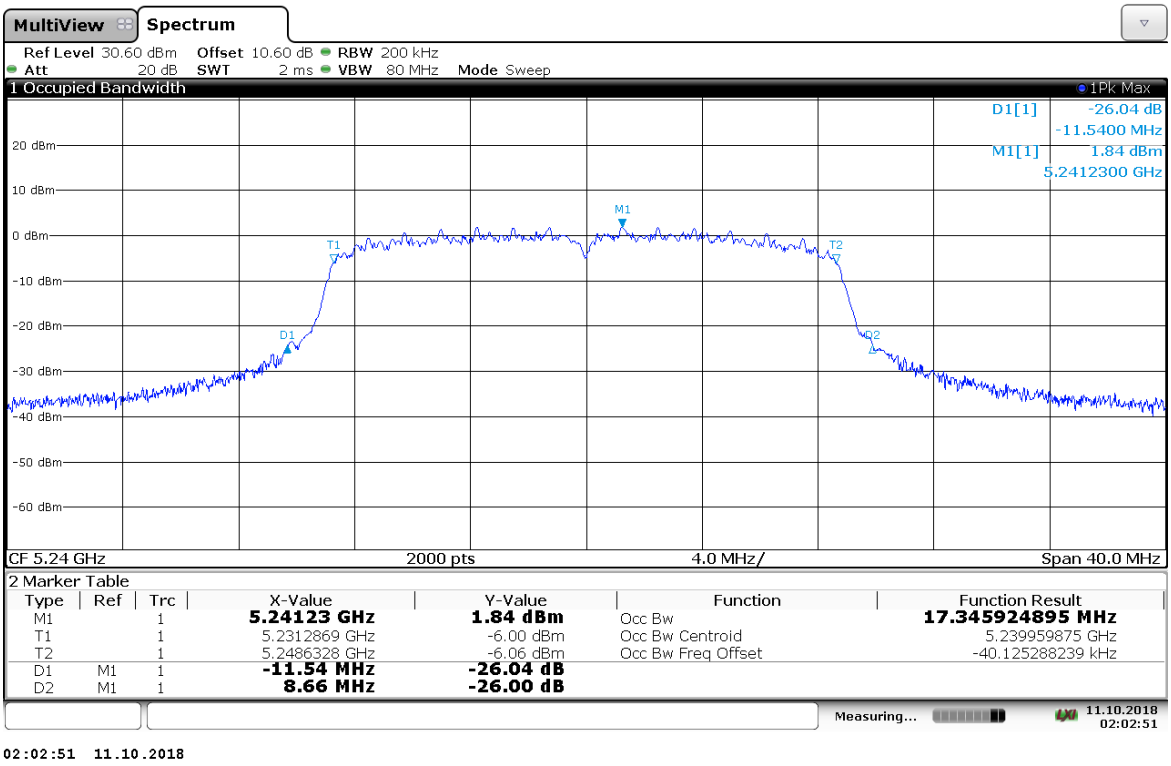


Figure 15: 99% Occupied and Emission Bandwidth, Channel 48 at 802.11n HT20 MCS3

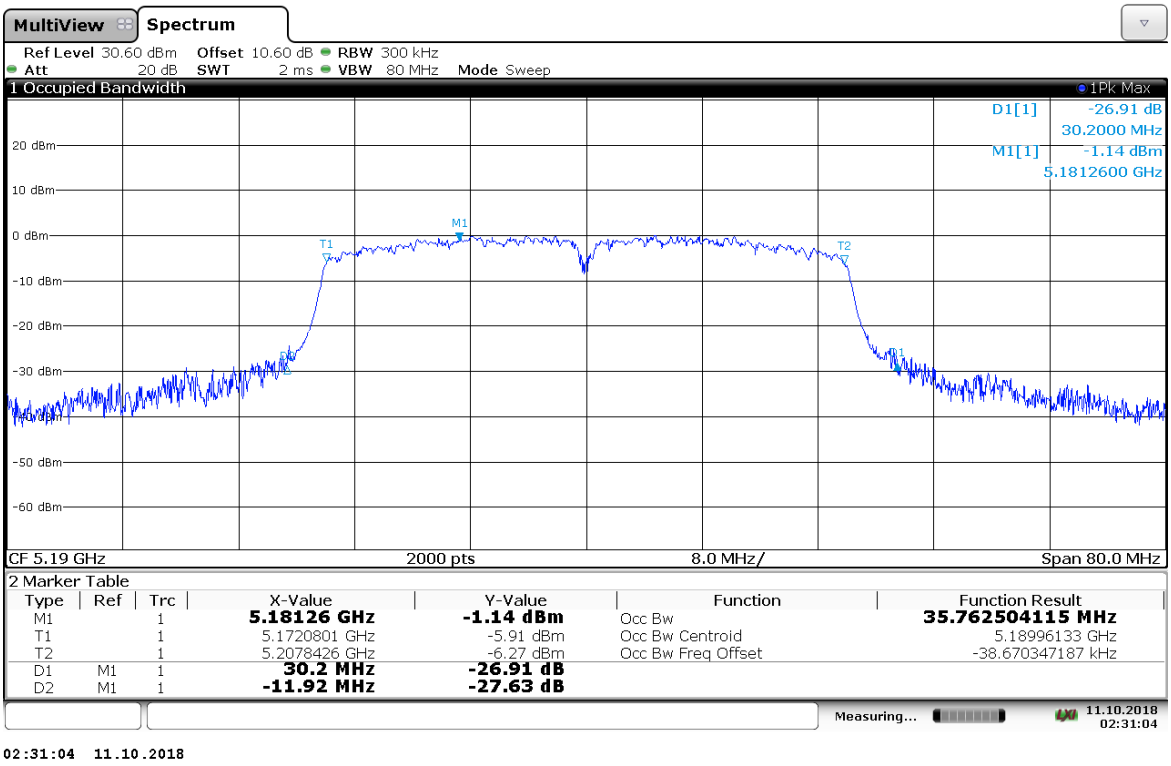


Figure 16: 99% Occupied and Emission Bandwidth, Channel 38 at 802.11n HT40+ MCS0

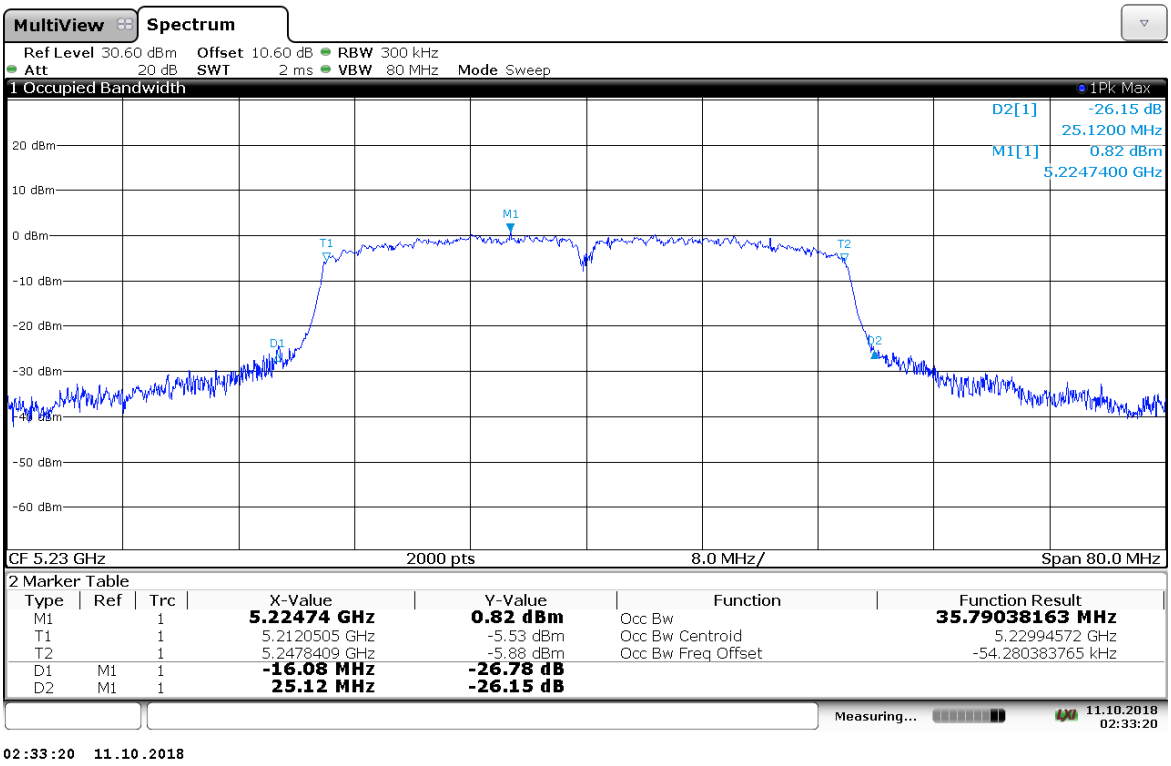


Figure 17: 99% Occupied and Emission Bandwidth, Channel 46 at 802.11n HT40+ MCS0

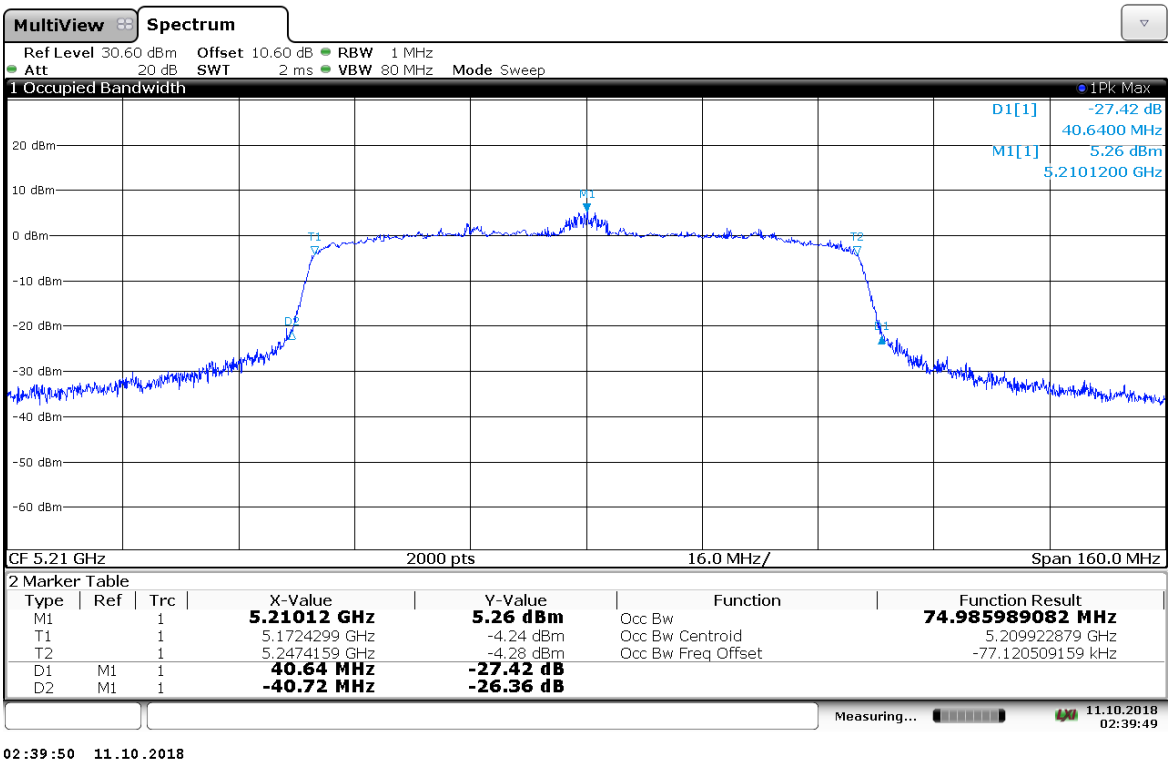


Figure 18: 99% Occupied and Emission Bandwidth, Channel 42 at 802.11ac VHT80 MCS1

4.2.4.1.2 UNII-3

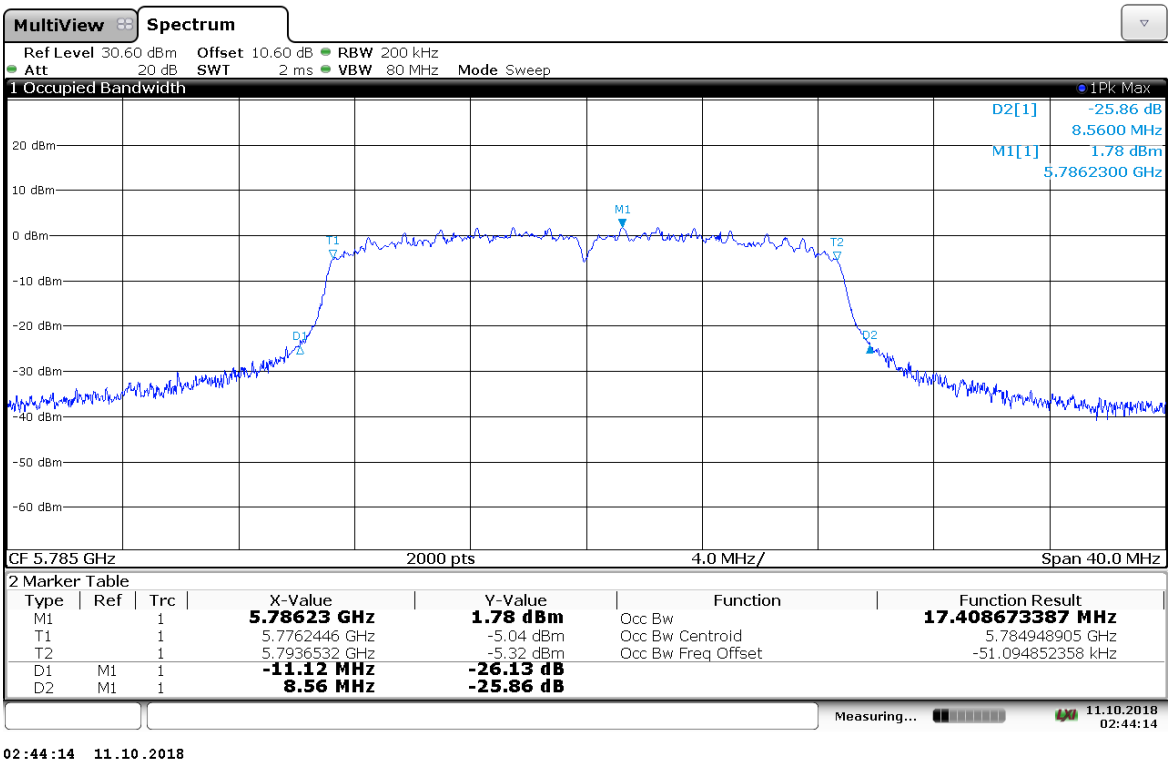


Figure 19: 99% Occupied Bandwidth, Channel 157 at 802.11n HT20 MCS3

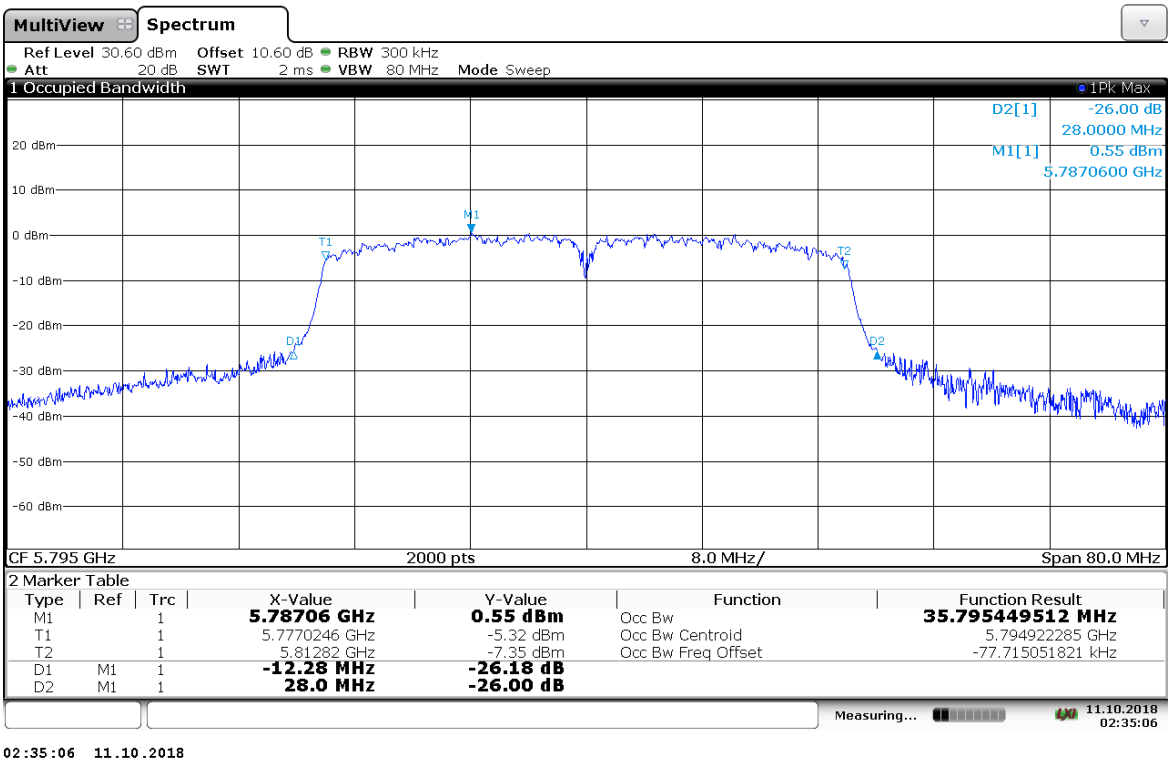


Figure 20: 99% Occupied Bandwidth, Channel 159 at 802.11n HT40+ MCS0

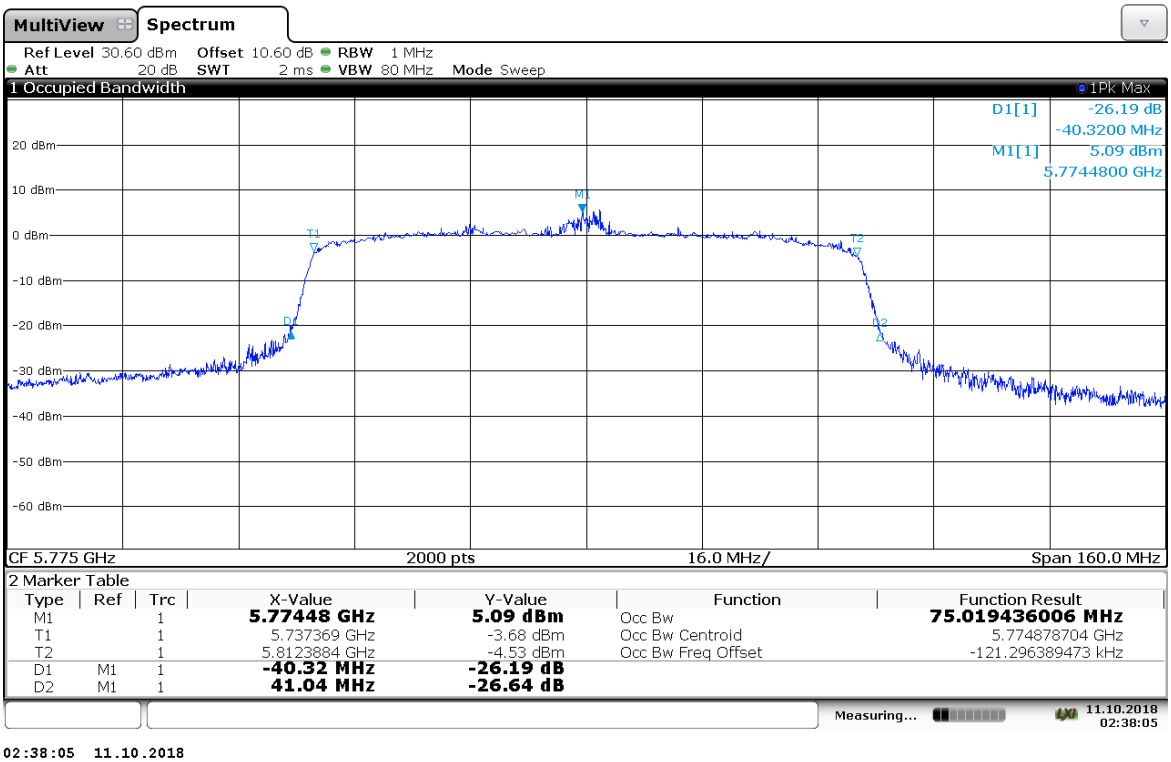


Figure 21: 99% Occupied Bandwidth, Channel 155 at 802.11ac VHT80 MCS1

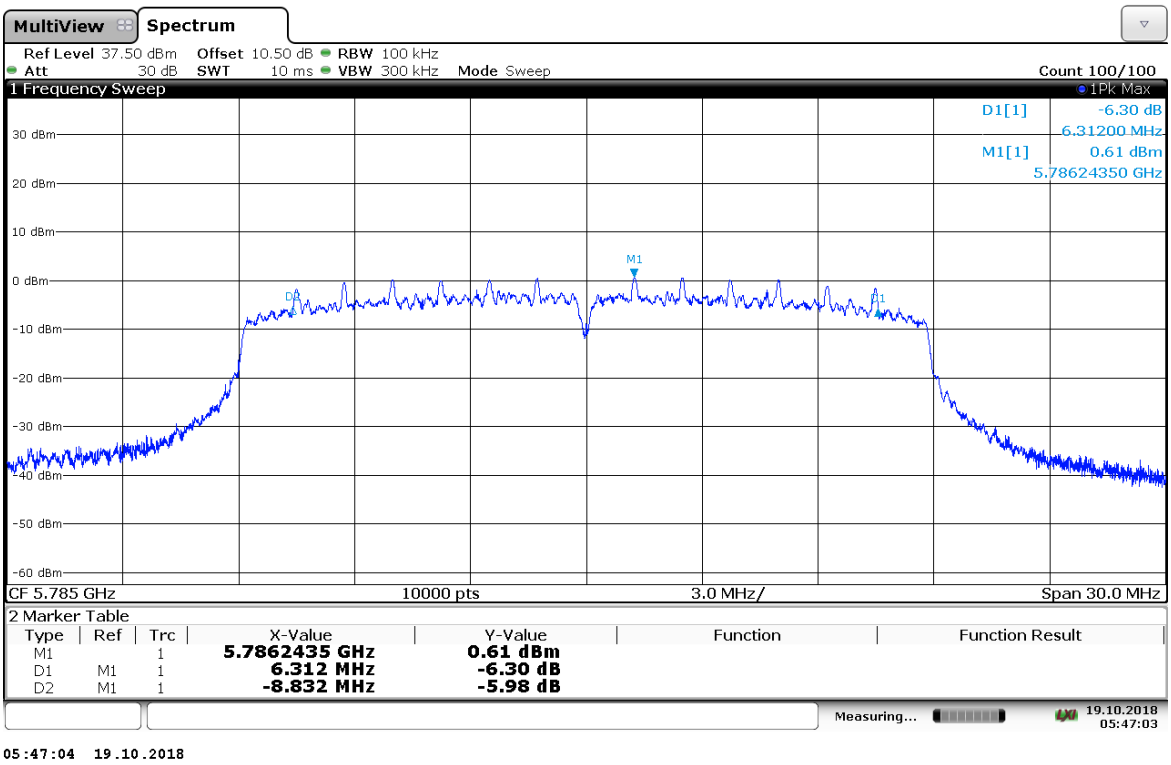


Figure 22: DTS Bandwidth, Channel 157 at 802.11n HT20 MCS3

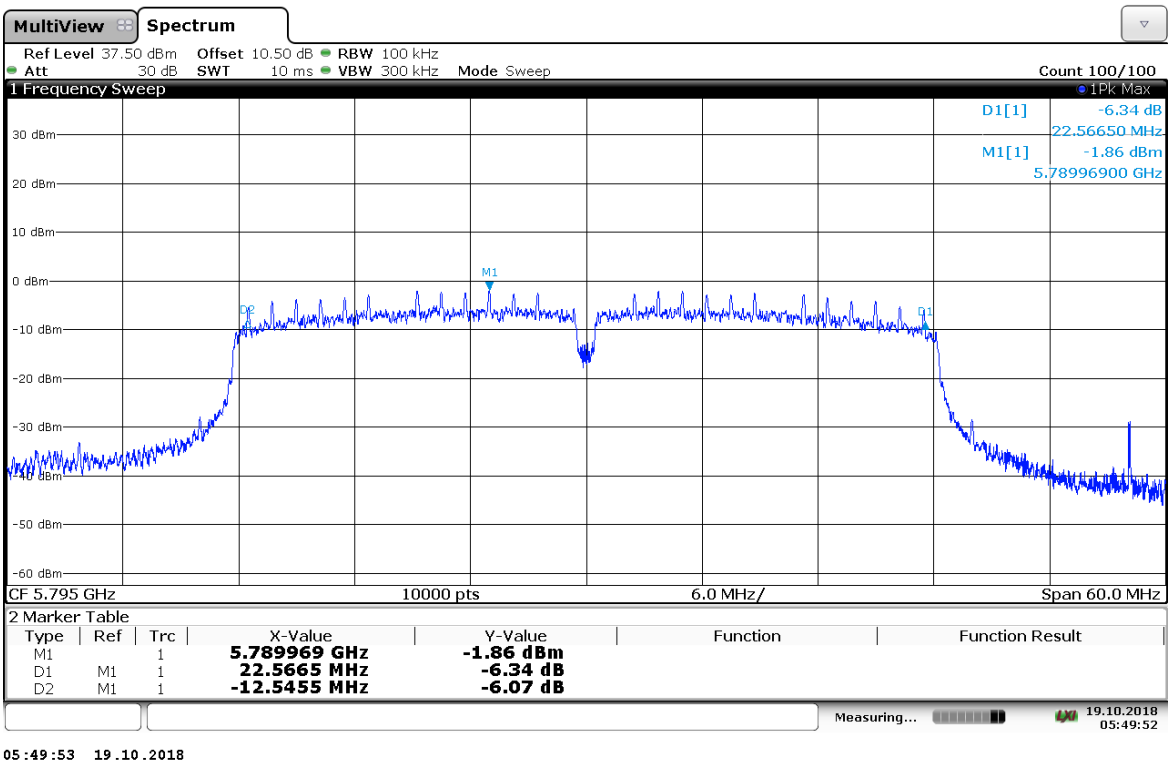


Figure 23: DTS Bandwidth, Channel 159 at 802.11n HT40+ MCS0

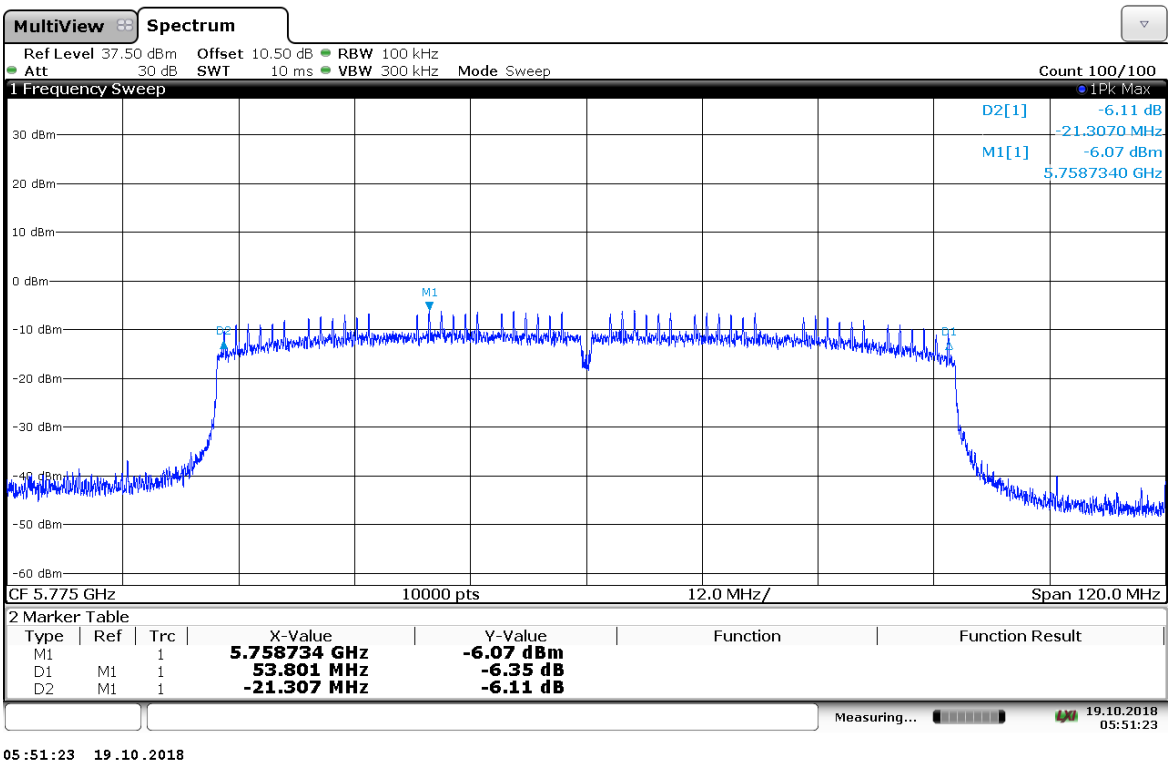


Figure 24: DTS Bandwidth, Channel 155 at 802.11ac VHT80 MCS 1

4.3 Peak Power Spectral Density (PPSD)

4.3.1 Limit(s)

U-NII-1 Band (5150-5250MHz):

FCC Part 15.407 (a):

17 dBm in any 1 MHz band

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RSS 247 Section 6.2.1.1:

10 dBm in any 1 MHz band, E.I.R.P.

U-NII-3 Band (5725-5850MHz):

FCC Part 15.407(a):

30 dBm in any 500KHz band

If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RSS 247 Section 6.2.4.1:

30 dBm in any 500KHz band

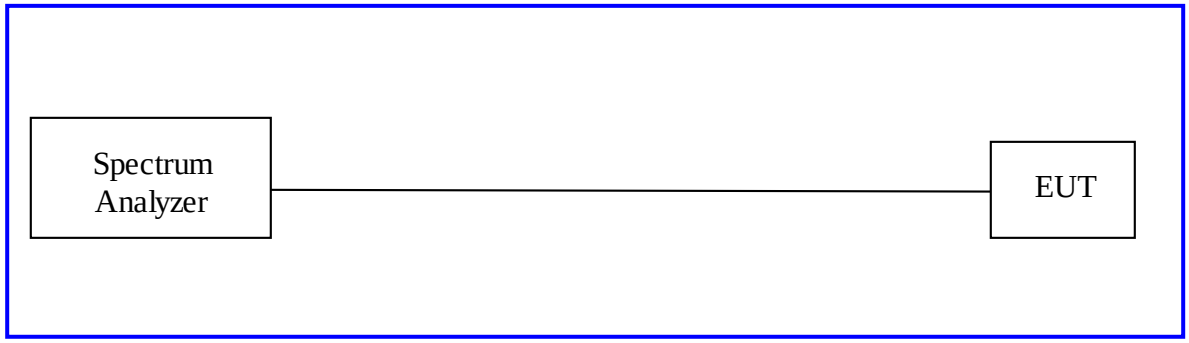
If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.3.2 Test Method

The conducted method was used to measure the power spectral density per ANSI C63.10-2013 section 12.5. A pre-evaluation was performed to find the worst case modes (Section 3.5 of this report). The worst findings were conducted on the low, middle and high channels, where applicable, in the operating frequency ranges of 5150-5250MHz and 5725-5850MHz.

U-NII-3 (5725-5850MHz) Peak power spectral density not measured as the RF output power is lower than the PPSD limit (30 dBm/500KHz) with a worst case occupied bandwidth of 17.4MHz.

4.3.3 Test Setup:



4.3.4 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

For U-NII-3 (5725-5850MHz) Peak power spectral density, the RF output power implies compliance as the RF output power is lower than the PPSD limit (30 dBm/500KHz) with a worse case occupied bandwidth of 16.4MHz.

Table 6: Peak Power Spectral Density – Test Results – FCC

UNII-1 (5150-5250MHz) Mode								
Mode	Channel	Bandwidth (MHz)	Frequency (MHz)	Power Setting	PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
802.11n HT20 MCS3	36	20	5180	12	-0.6	17	17.6	Pass
	44	20	5220	12	-0.4	17	17.4	Pass
	48	20	5240	12	-0.2	17	17.2	Pass
802.11n HT40+ MCS0	38	40	5190	12	-2.9	17	19.9	Pass
	46	40	5230	12	-3.0	17	20.0	Pass
802.11ac VHT80 MCS1	42	80	5210	11	-7.0	17	24.0	Pass

Table 7: Peak Power Spectral Density – Test Results – ISED

UNII-1 (5150-5250MHz) Mode										
Mode	Channel	Bandwidth (MHz)	Frequency (MHz)	Power Setting	PPSD (dBm/ MHz)	Antenna Gain (dBi)	PSD EIRP (dBm/ MHz)	EIRP Limit (dBm/ MHz)	Margin (dB)	Result
802.11n HT20 MCS3	36	20	5180	12	-0.6	0.7	0.1	10	9.9	Pass
	44	20	5220	12	-0.4	0.7	0.3	10	9.7	Pass
	48	20	5240	12	-0.2	0.7	0.5	10	9.5	Pass
802.11n HT40+ MCS0	38	40	5190	12	-2.9	0.7	-2.2	10	12.2	Pass
	46	40	5230	12	-3.0	0.7	-2.3	10	12.3	Pass
802.11ac VHT80 MCS1	42	80	5210	11	-7.0	0.7	-6.3	10	16.3	Pass

4.3.4.1 Measurement Plots

Note: Plots only reflect corrections for cable loss.

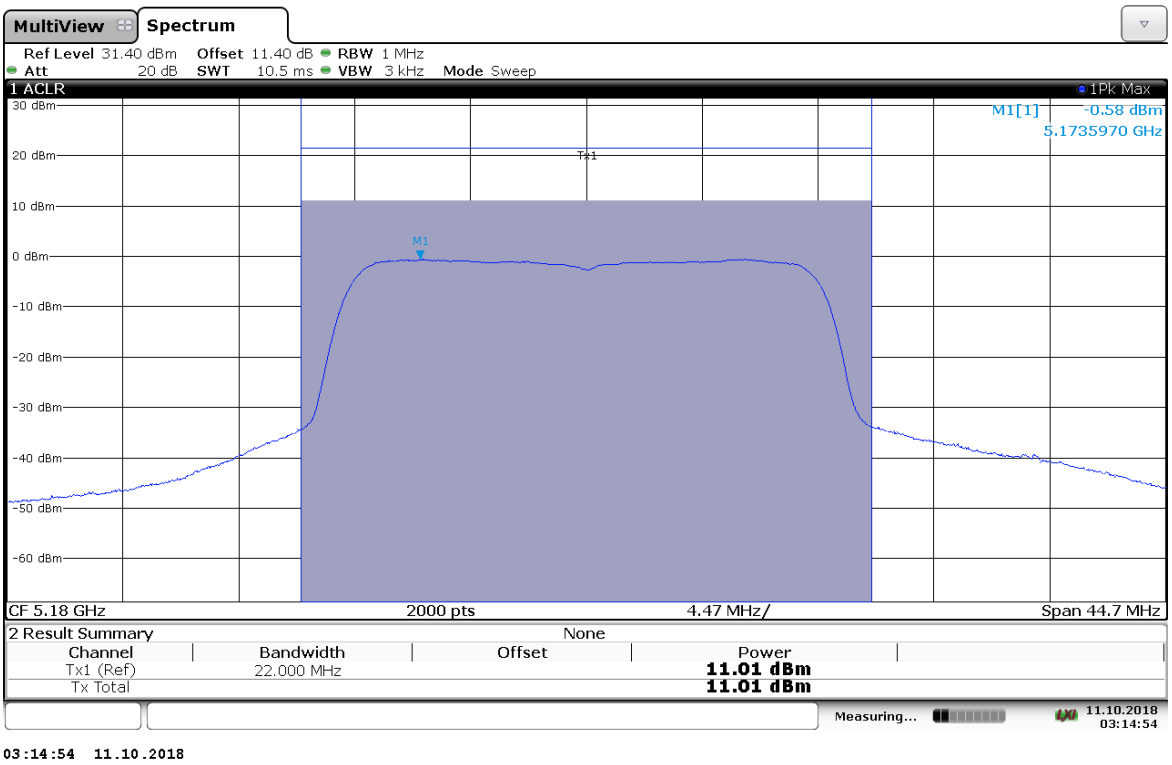


Figure 25: Power Spectral Density, Channel 36 802.11n HT20 MCS3

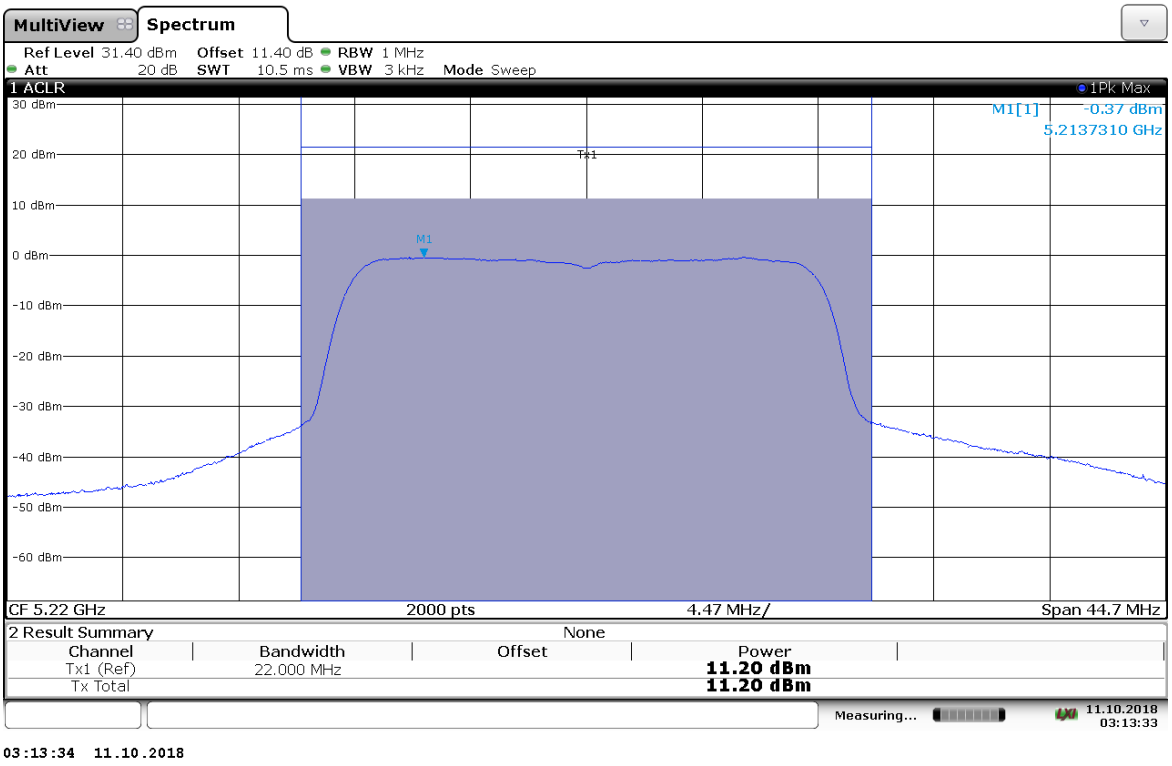


Figure 26: Power Spectral Density, Channel 44 802.11n HT20 MCS3

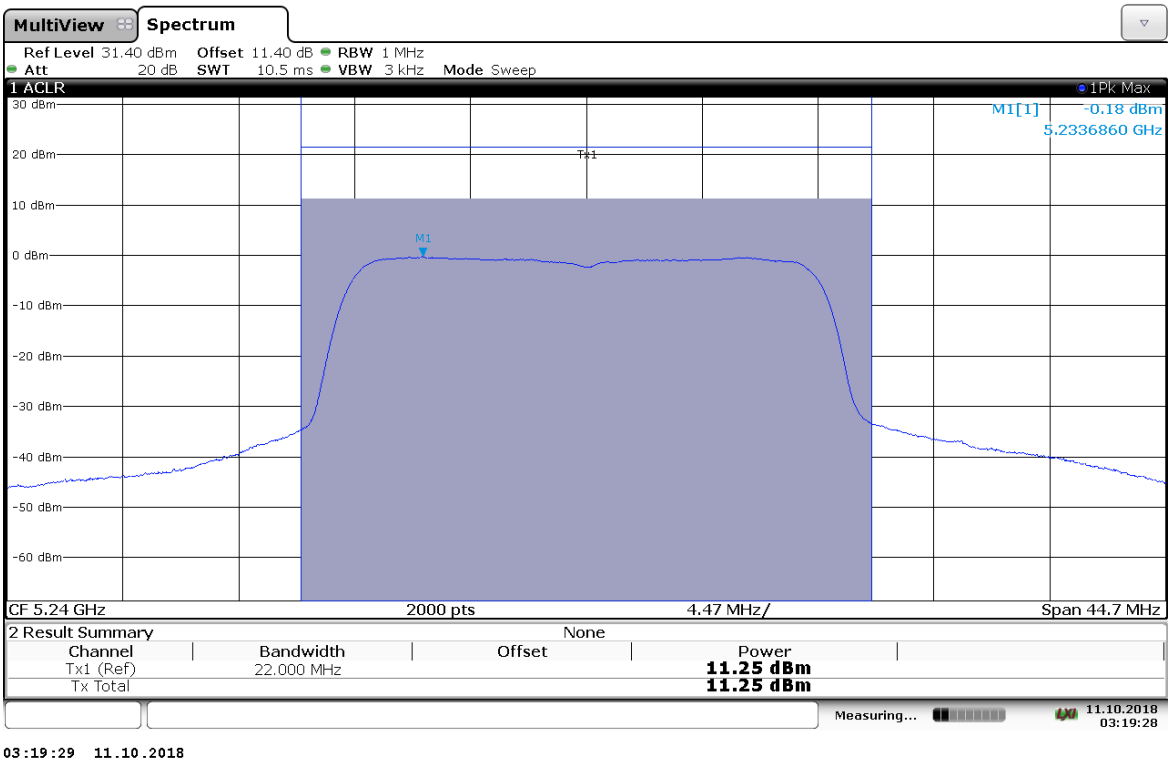


Figure 27: Power Spectral Density, Channel 48 802.11n HT20 MCS3

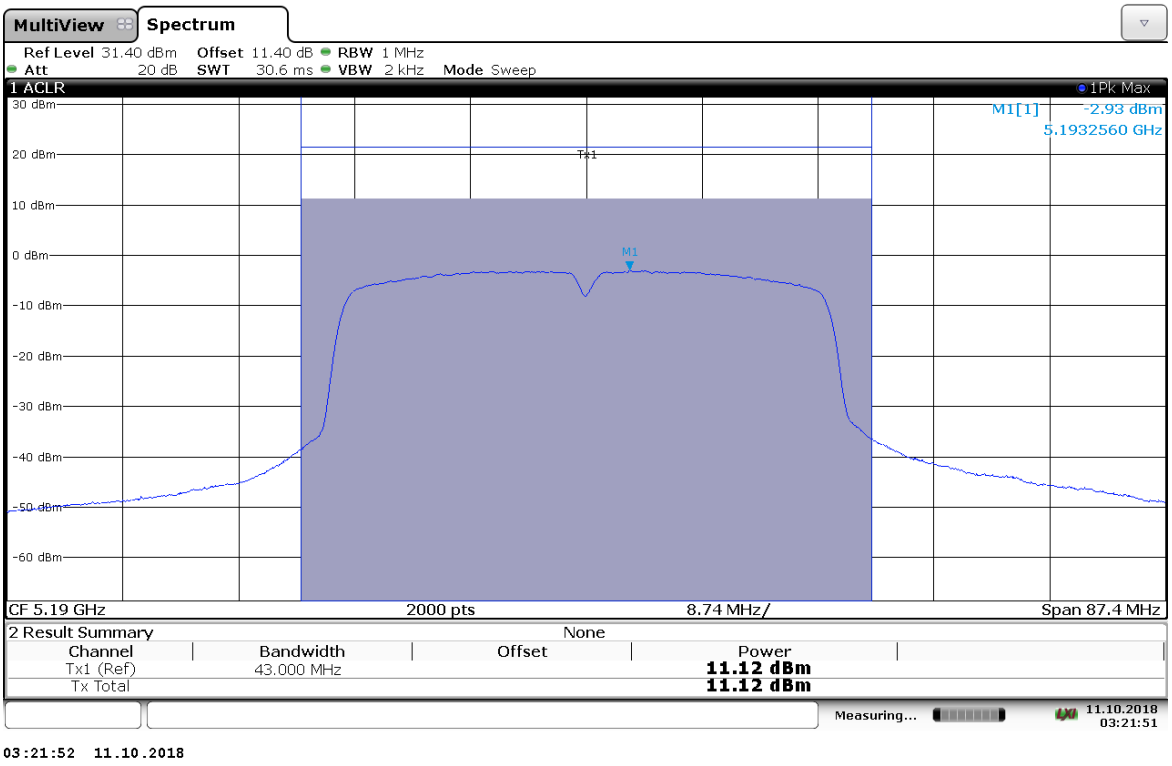


Figure 28: Power Spectral Density, Channel 38 802.11n HT40+ MCS0

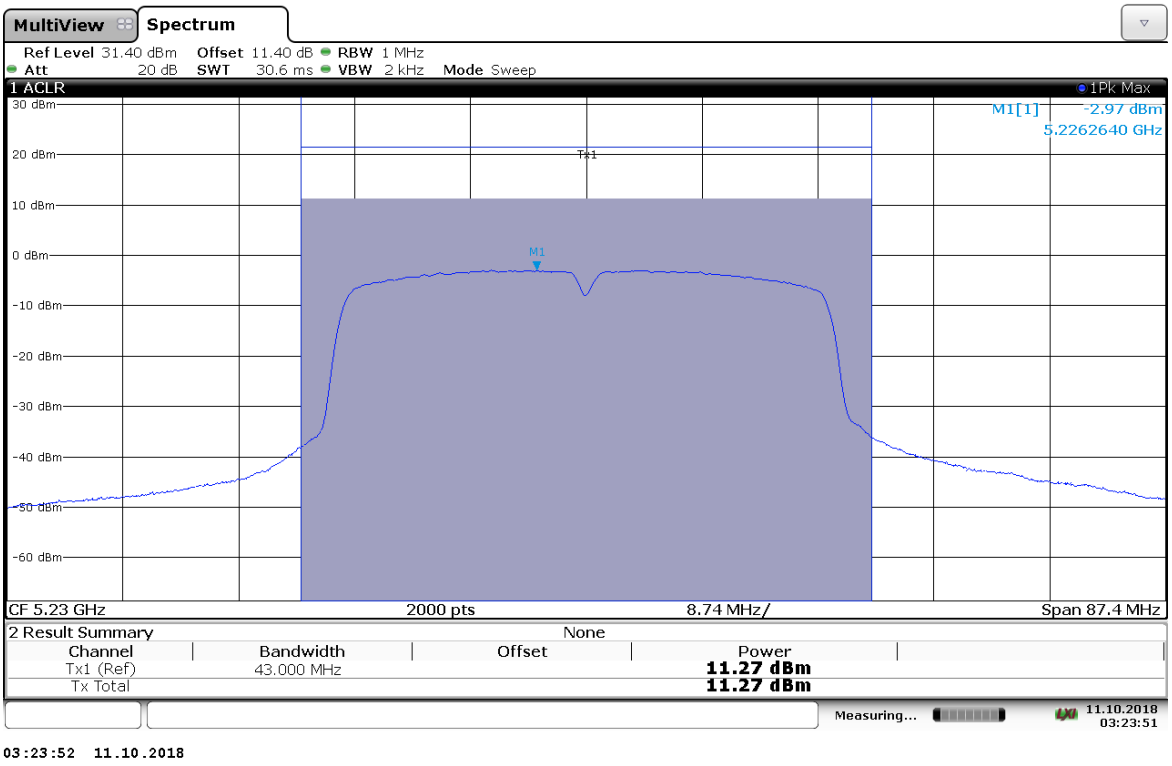


Figure 29: Power Spectral Density, Channel 46 802.11n HT40+ MCS0

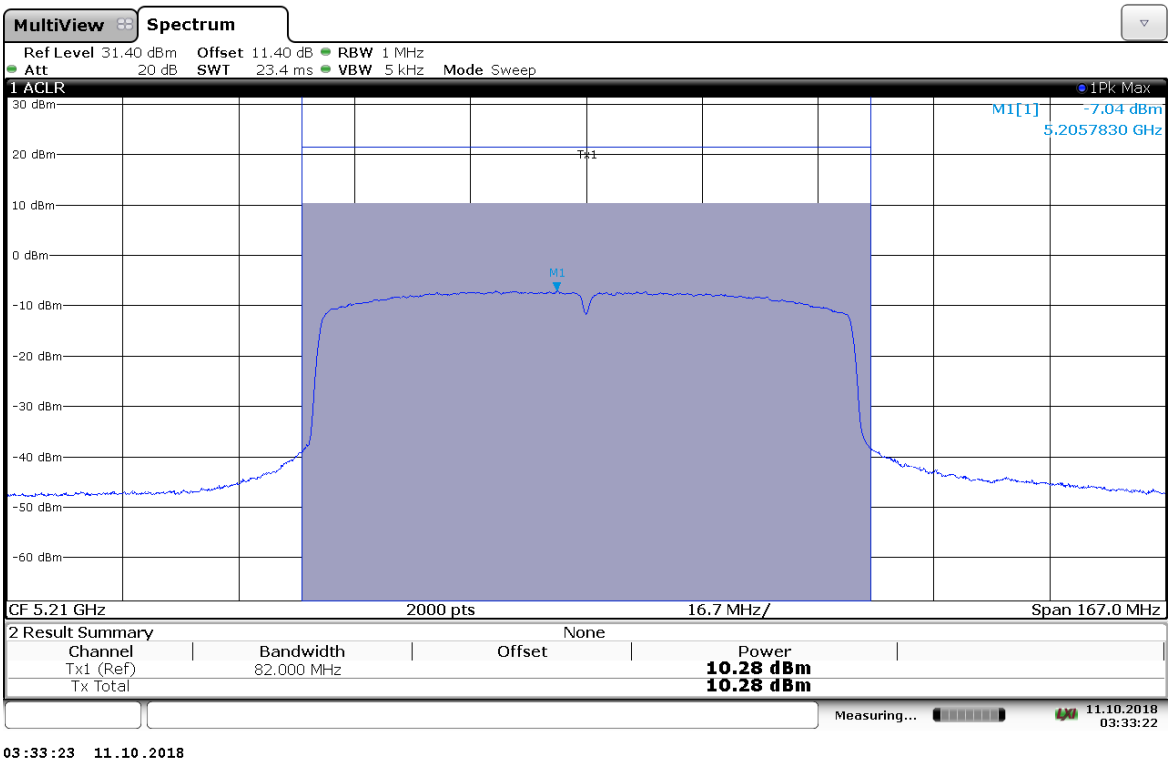


Figure 30: Power Spectral Density, Channel 42 802.11ac VHT80 MCS1

4.4 Out of Band Emissions: UNII-1 Restricted Band Edge

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmitting mode; per requirement of CFR47 15.205, 15.209, 15.407, RSS-247 Sect. 6.2, RSS-GEN Sect. 8.9 and 8.10.

4.4.1 Limit(s)

§15.205(a) Restricted Bandedge at 4.5-5.15GHz:

Peak Detector Limit: 74 dBuV/m
Average Detector Limit: 54 dBuV/m

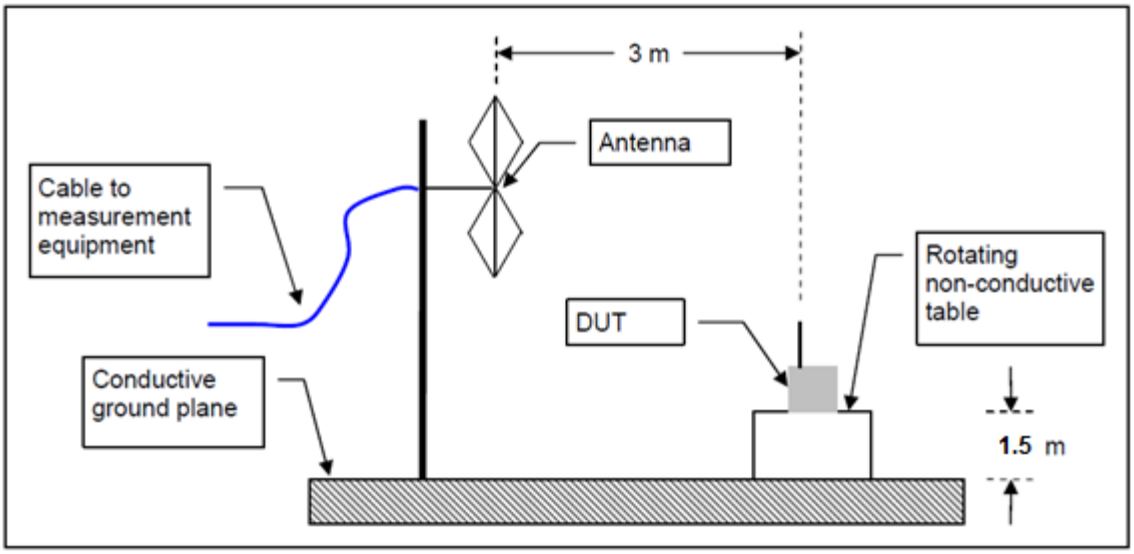
4.4.2 Test Method

Radiated measurements per ANSI C63.10-2013 Section 6.10.5 and 12.7.7.3 Method VB-A were used to measure the undesirable emission requirement in restricted bands. The measurement was performed with modulation. This test was conducted on 3 channels, where applicable, in each mode on the EUT. The power settings used are in section 4.1.4.1 of this report.

4.4.3 Test Setup

Spectrum Analyzer Settings:

	Peak Measurement	Average Measurement
Detector	Peak	Peak
Trace	Max Hold	Max Hold
RBW	1 MHz	1 MHz
VBW	3 MHz	See Section 4.4.4
Sweep Points	201	201
Sweep Time	Coupled	Coupled
Span	See Plots	See Plots



The DUT was stimulated by manufacturer provided test software that is not available to the end user.

4.4.4 Transmission Duration

Due to duty cycle of less than 98% and deviations of greater than 2%, a reduced video bandwidth was used per KDB 789033 D02 General UNII Test Procedures New Rules v02r01 section 6(d).

Mode	Measured Transmission Duration (us)	Video Bandwidth (KHz)
802.11n MCS3	495.7	3
802.11n HT40+ MCS0	936.8	2
802.11ac VHT80 MCS1	240.1	5

See section 4.1.5.3 for plots.

4.4.5 Test Results

Table 8: Emissions at the UNII-1 Low Band-Edge – Test Results

Test Conditions: Radiated Measurement, Normal Temperature and Voltage							
Antenna Type: PCB type F dual band antenna				**Power Setting:** See Section 4.1.4.1			
Max. Antenna Gain: 0.7 dBi							
Signal State: See Section 4.1.5.3							
Ambient Temp.: 22° C				**Relative Humidity:** 38%			
Freq. (MHz)	**Mode**	**Channel**	**Detector (Average/ Peak)**	**Measured (dBuV/m)**	**Limit (dBuV/m)**	**Margin**	**Results**
5150	802.11n HT20 MCS3	36	Average	45.0	54	9.0	Pass
5150	802.11n HT20 MCS3	36	Peak	57.7	74	16.3	Pass
5150	802.11n HT40+ MCS0	38	Average	52.0	54	2.0	Pass
5149	802.11n HT40+ MCS0	38	Peak	70.7	74	3.3	Pass
5150	802.11ac VHT80 MCS1	42	Average	51.7	54	2.3	Pass
5149	802.11ac VHT80 MCS1	42	Peak	64.7	74	9.3	Pass

4.4.5.1 Plots: UNII-1 Low Band Edge Mode

Note: Plots depict worse case antenna polarization and EUT orientation.

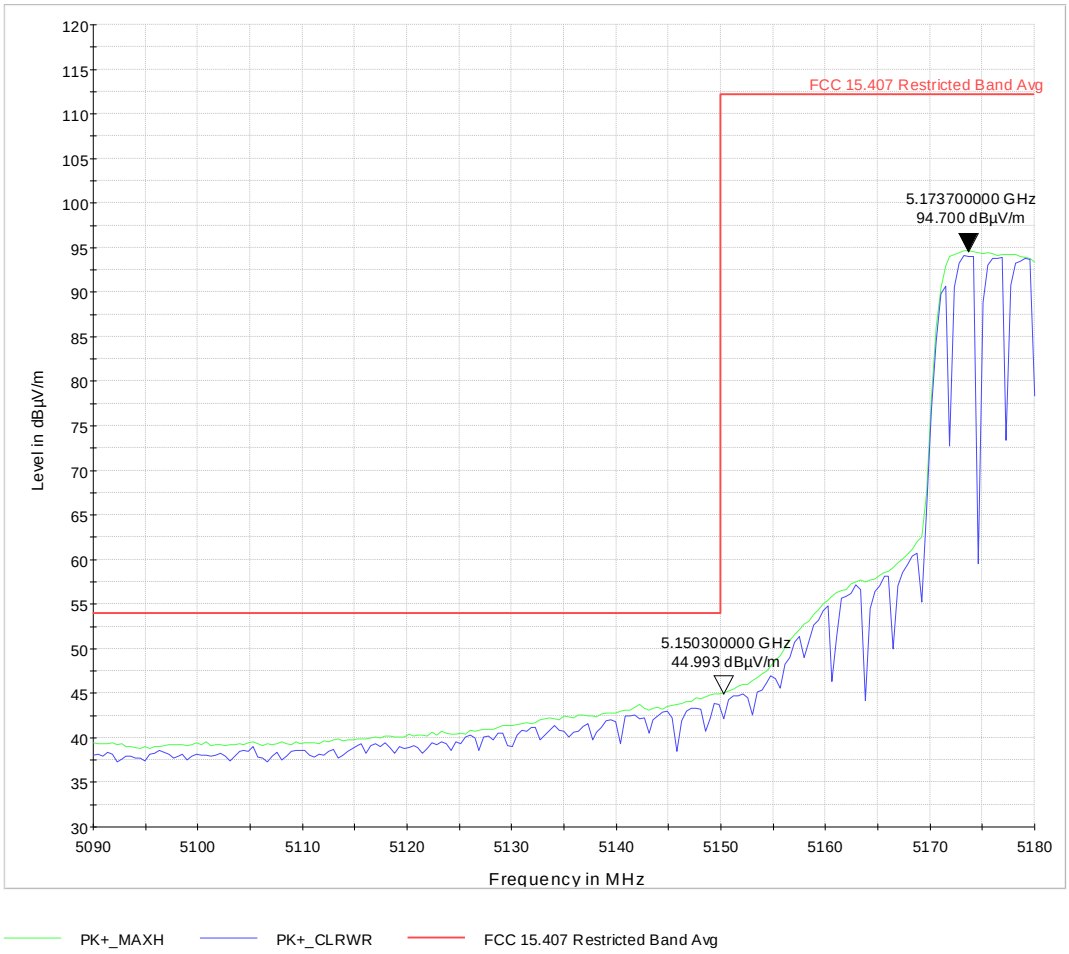


Figure 31: UNII-1 Low Band Edge for 802.11n HT20 MCS3 at 5180 MHz-Average

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

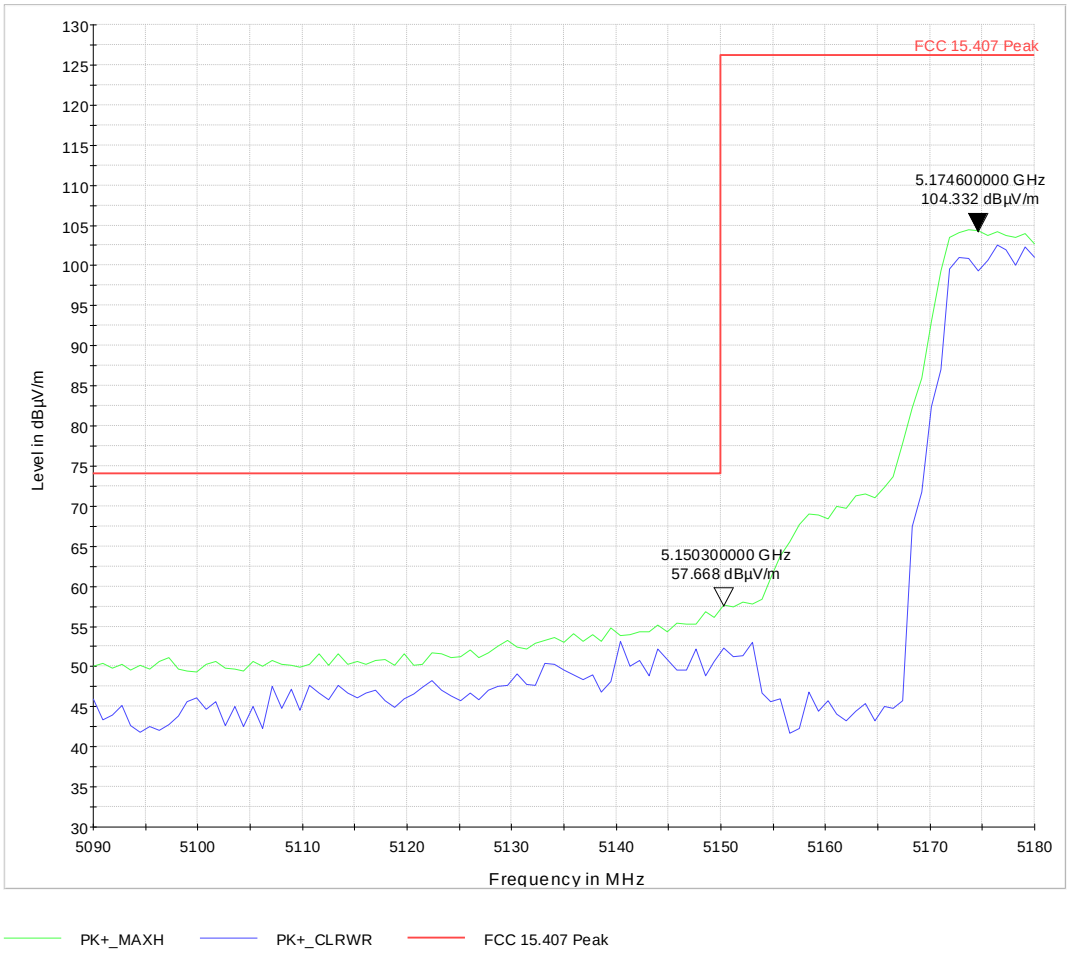


Figure 32: UNII-1 Low Band Edge for 802.11n HT20 MCS3 at 5180 MHz-Peak

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

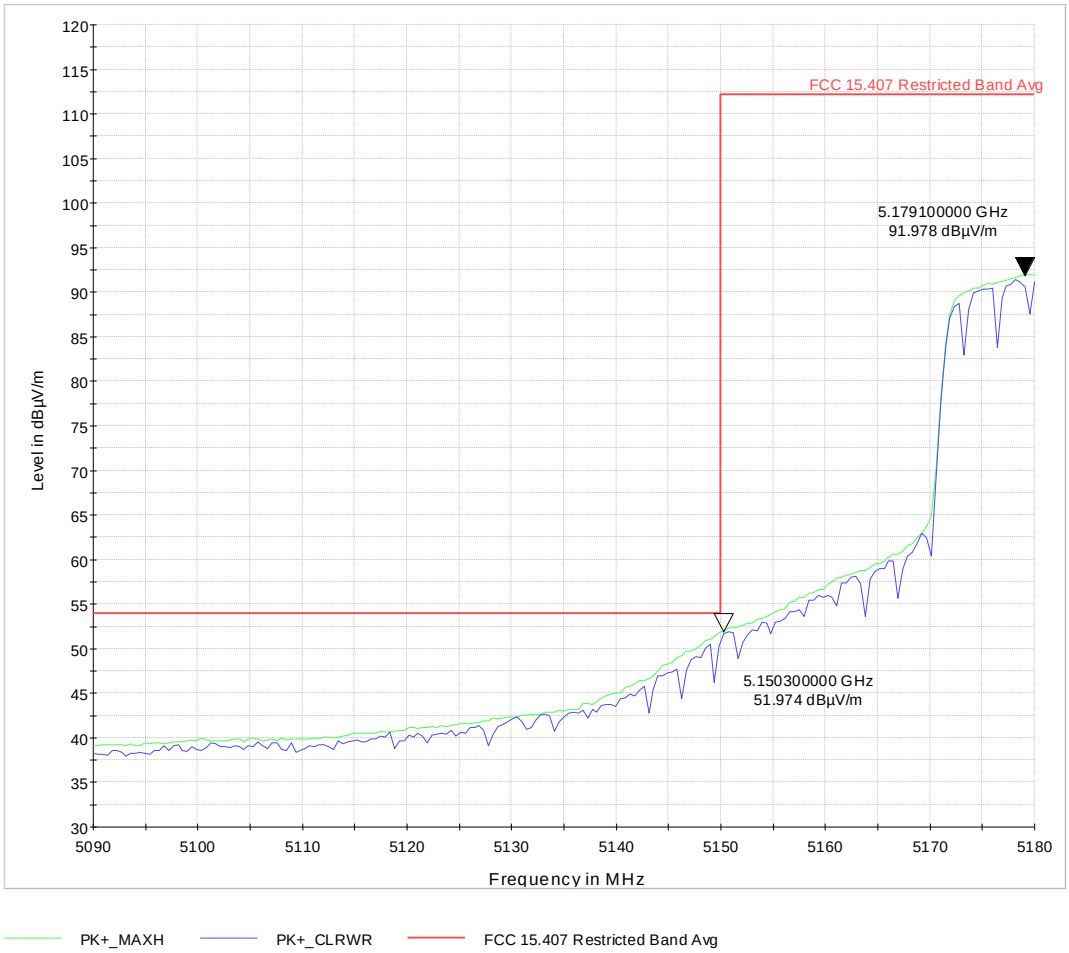


Figure 33: UNII-1 Low Band Edge for 802.11n HT40 MCS0 at 5190 MHz-Average

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

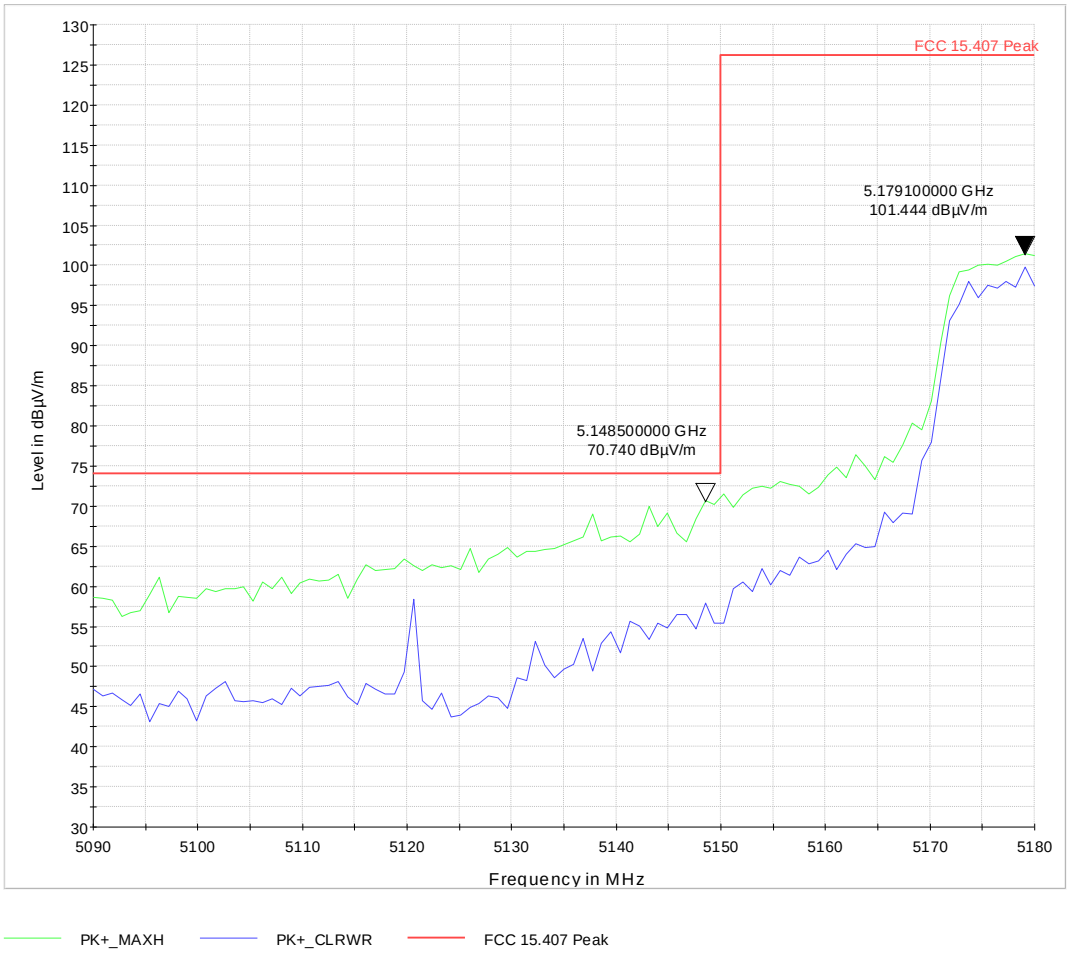


Figure 34: UNII-1 Low Band Edge for 802.11n HT40 MCS0 at 5190 MHz-Peak

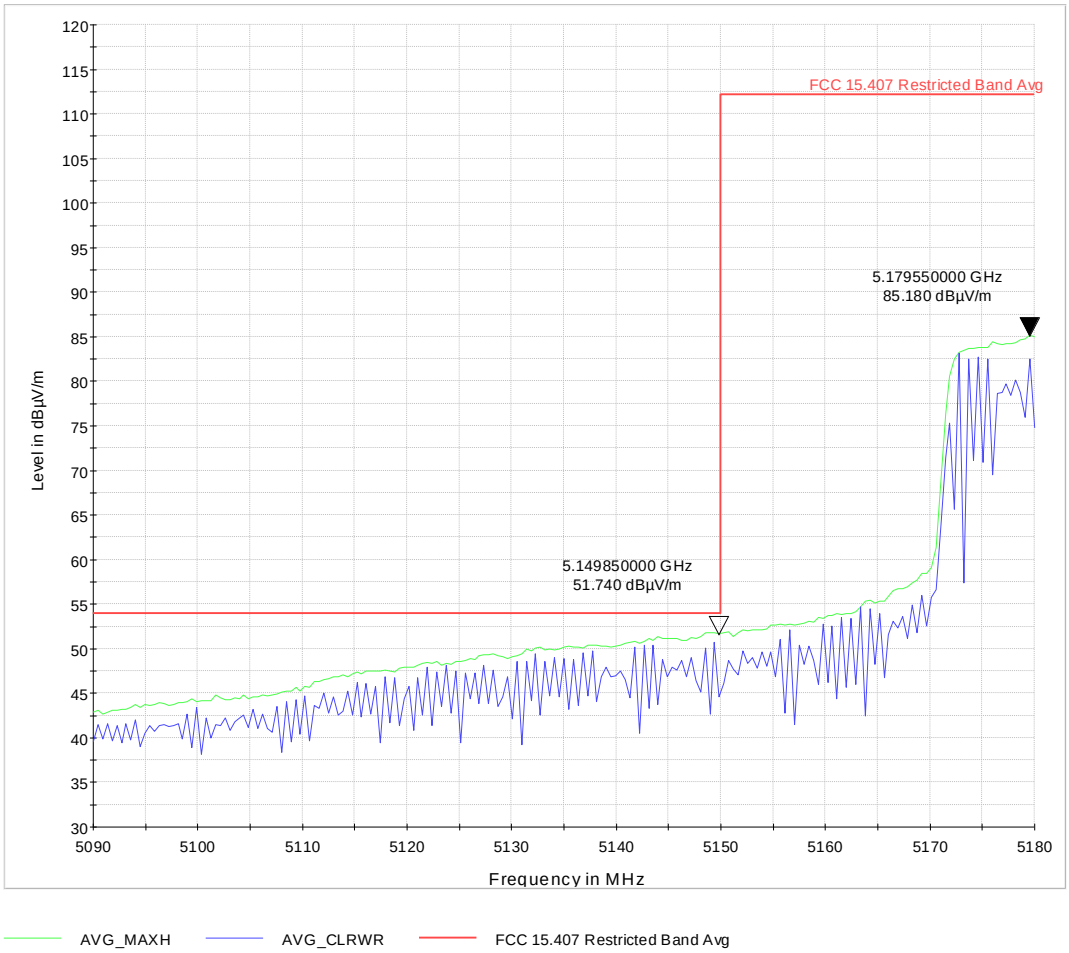


Figure 35: UNII-1 Low Band Edge for 802.11ac VHT80 MCS1 at 5210 MHz-Average

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

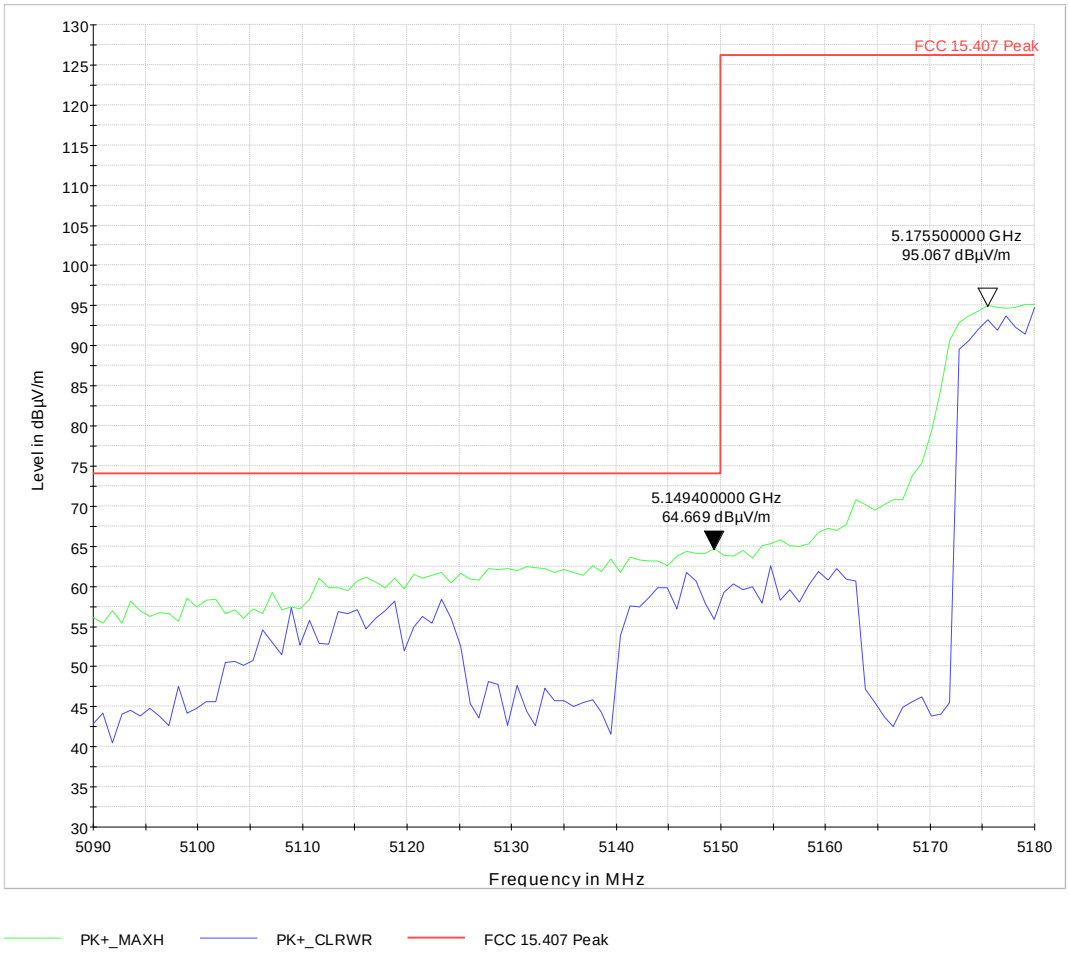


Figure 36: UNII-1 Low Band Edge for 802.11ac VHT80 MCS1 at 5210 MHz-Peak

4.5 Out of Band Emissions: UNII-3 Non-restricted Band Edge

4.5.1 Limit(s)

CFR47 15.407 (b)(4)(i) and RSS 247 Sect.6.2.1.2: The maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(4) For transmitters operating in the 5.725-5.85 GHz band:

(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

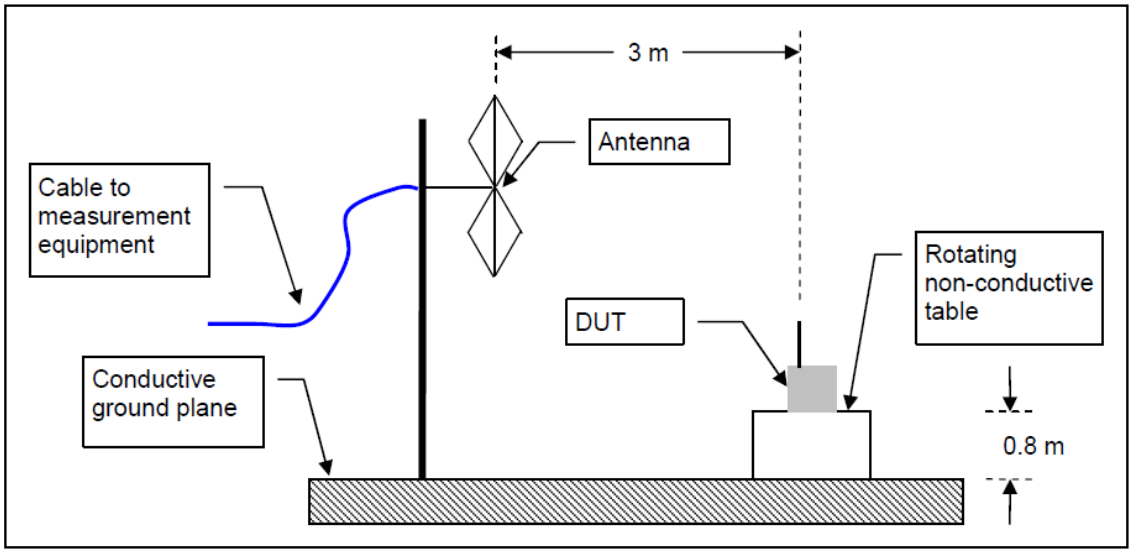
4.5.2 Test Method

Radiated measurements per ANSI C63.10-2013 Section 12.7.7.3 were used to measure the undesirable emission requirement in non-restricted bands. The measurement was performed with modulation. This test was conducted on the low channel for the low bandedge and the high channel for the high bandedge, in each applicable mode on the EUT. Preliminary tests were done to find the worse case modes (section 3.5.2 of this report). The power settings that were implemented are in section 4.1.4.1 of this report.

4.5.3 Test Setup

Spectrum Analyzer Settings:

	Peak Measurement
Detector	Peak
Trace	Max Hold
RBW	1 MHz
VBW	3 MHz
Sweep Points	501
Sweep Time	Coupled
Span	See Plots



The DUT was stimulated by manufacturer provided test software that is not available to the end user.

4.5.4 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.5.5 Measurement Plots

Note: Plots depict worse case antenna polarization and EUT orientation.

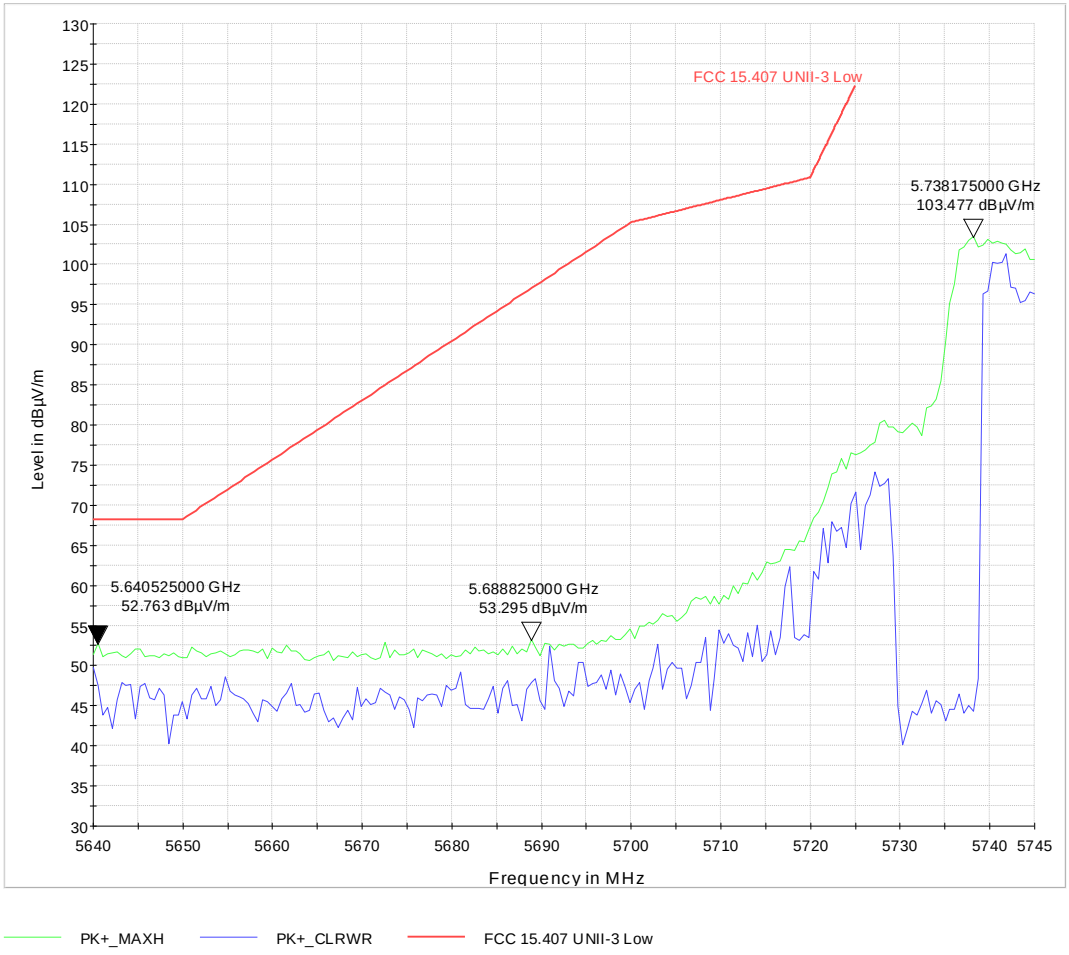


Figure 37: Low U-NII-3 band edge for 802.11n HT20 MCS3 at Channel 149

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

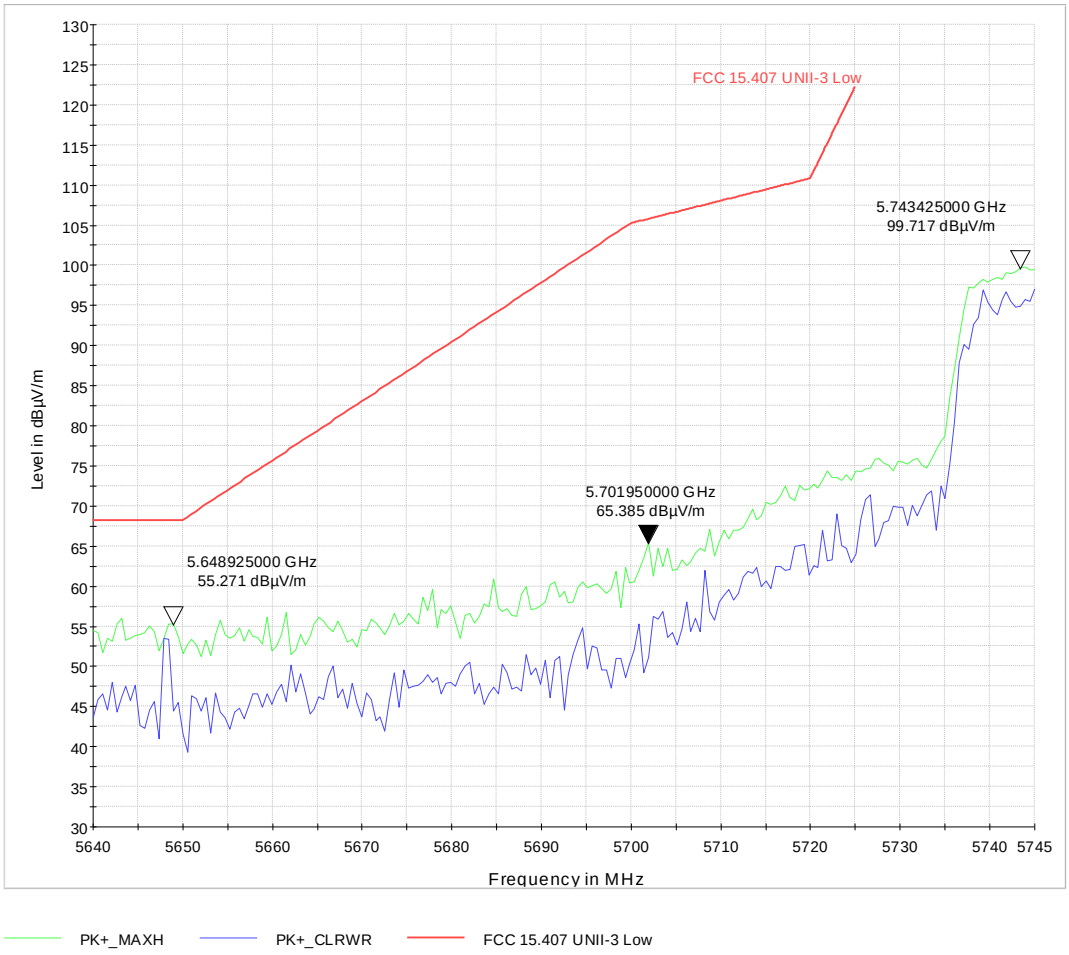


Figure 38: Low U-NII-3 band edge for 802.11n HT40+ MCS0 at Channel 151

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

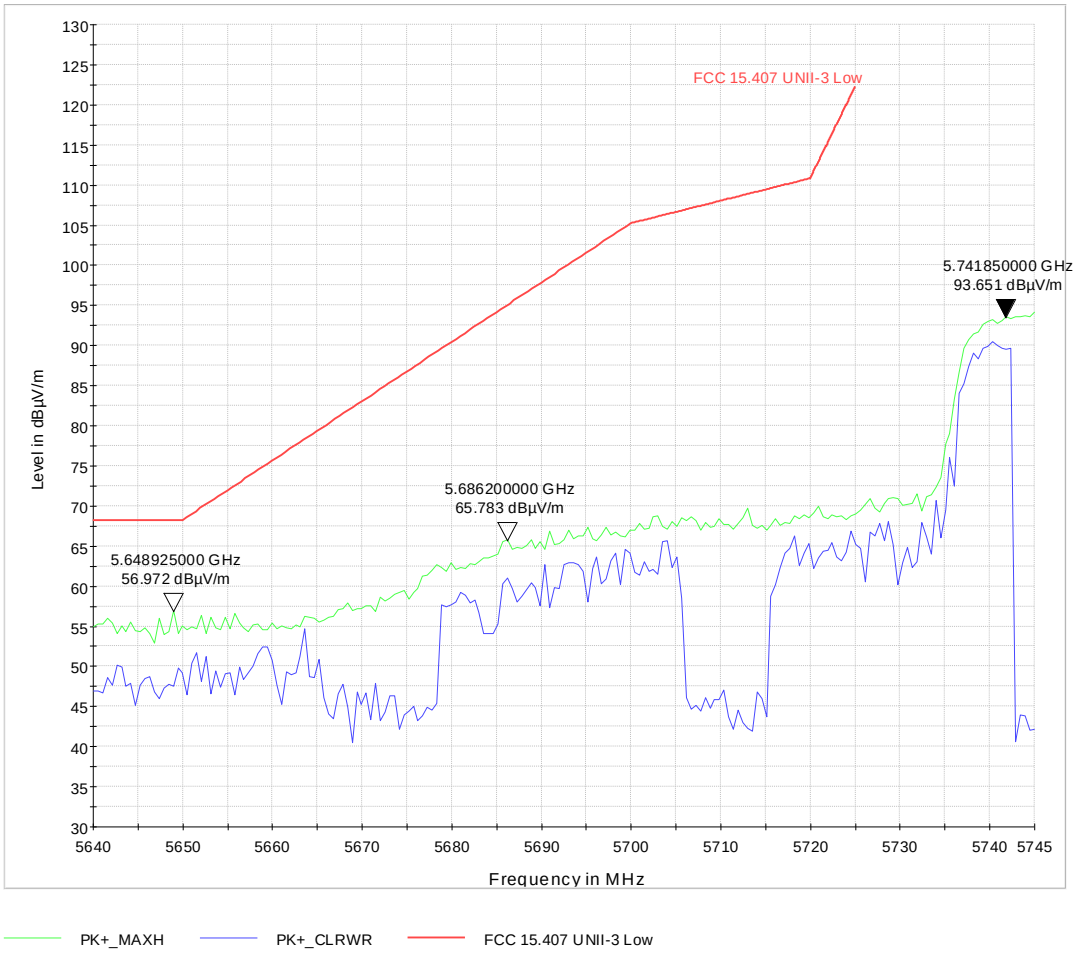


Figure 39: Low U-NII-3 band edge for 802.11ac VHT80 MCS1 at Channel 155

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

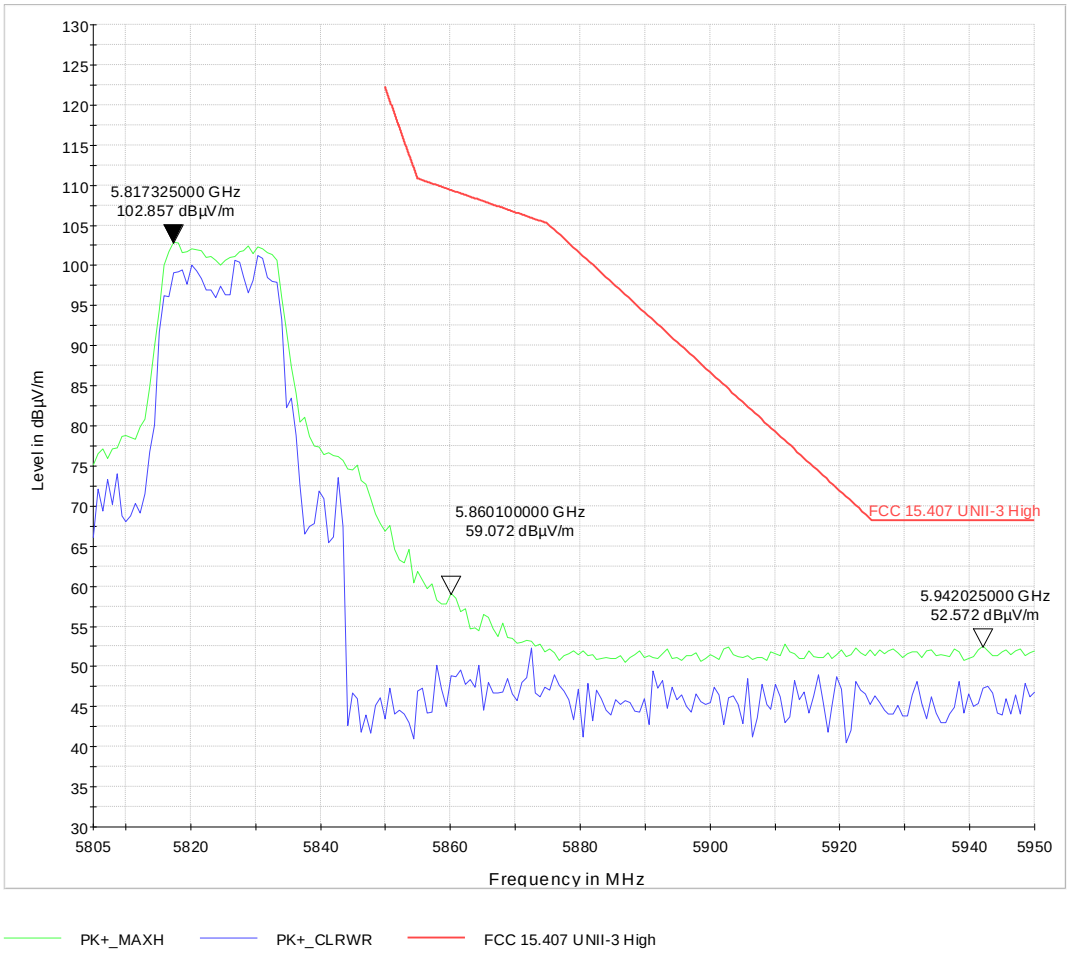


Figure 40: High U-NII-3 band edge for 802.11n HT20 MCS3 at Channel 165

1279 Quarry Lane, Ste. A, Pleasanton, CA 95466
Tel: (925) 249-9123, Fax: (925) 249-9124

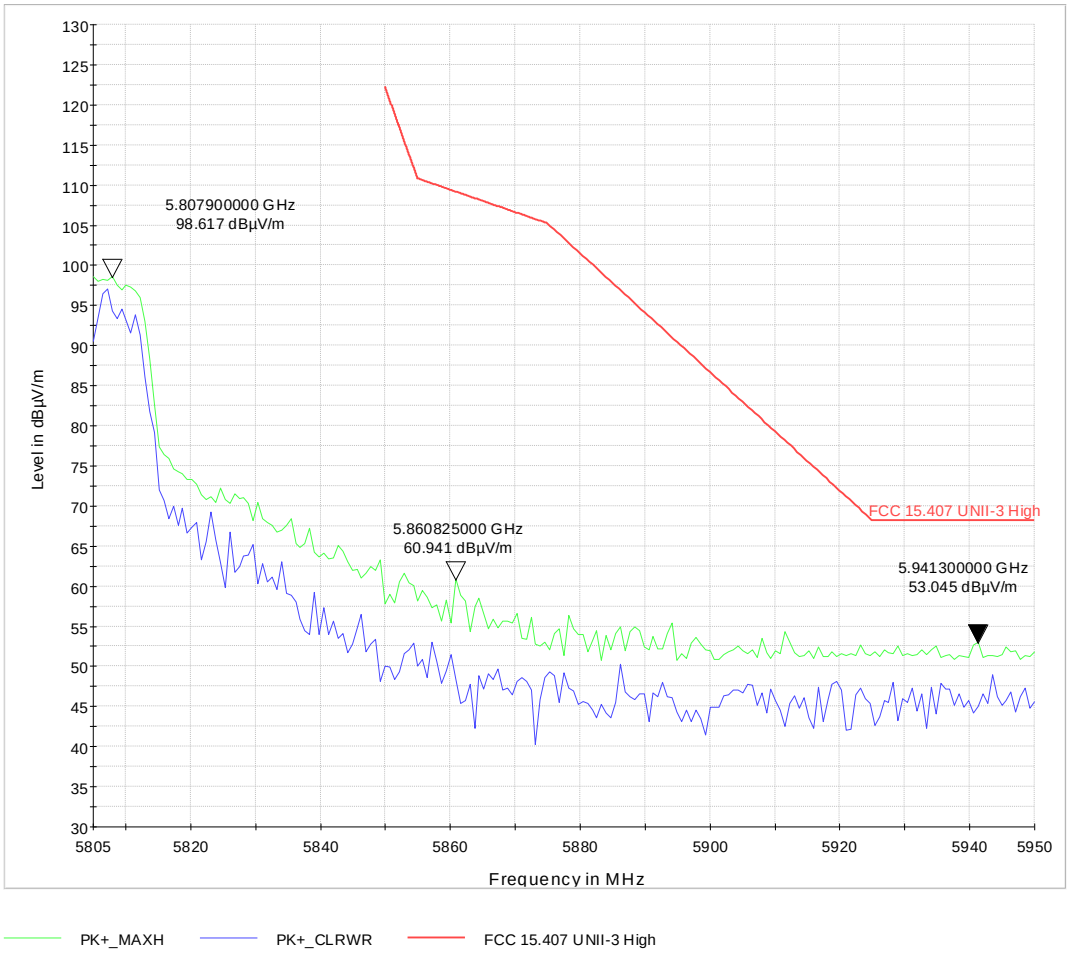


Figure 41: High U-NII-3 band edge for 802.11n HT40+ MCS0 at Channel 159

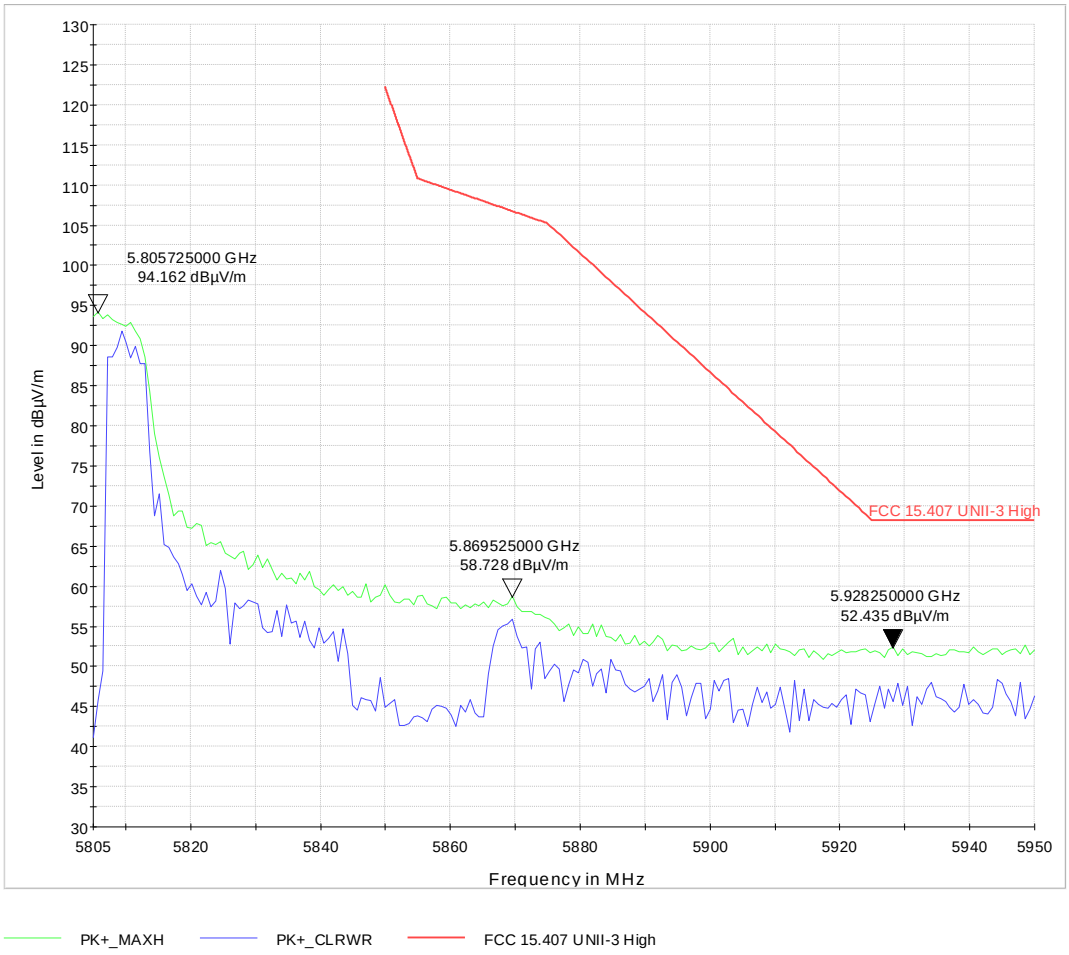


Figure 42: High U-NII-3 band edge for 802.11ac VHT80 MCS1 at Channel 155

4.6 Transmitter Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205:2016, 15.209:2016, 15.407(b:2016), RSS 247 Sect. 6:2017, RSS GEN Sect.8.9 and 8.10:2014

4.6.1 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209, RSS 247 Sect. 6, RSS GEN Sect. 8.9 and 8.10

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490.....	2400/F(kHz)	300
0.490-1.705.....	24000/F(kHz)	30
1.705-30.0.....	30	30
30-88.....	100 **	3
88-216.....	150 **	3
216-960.....	200 **	3
Above 960.....	500	3

According to CFR47 15.407 (b) and RSS 247 Sect. 6.2.1.2, all harmonics and spurious emissions which are outside the 5150 MHz - 5250 MHz, 5250 MHz – 5350 MHz, or 5470 MHz – 5725 MHz shall not exceed -27 dBm/MHz. This is equivalent to 68.2 dBuV/m at 3 meter distance.

4.6.2 Test Methodology

4.6.2.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

Pres-scans were performed to determine the worst, data rate/ chains (section 3.5.2 of this report).

4.6.2.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

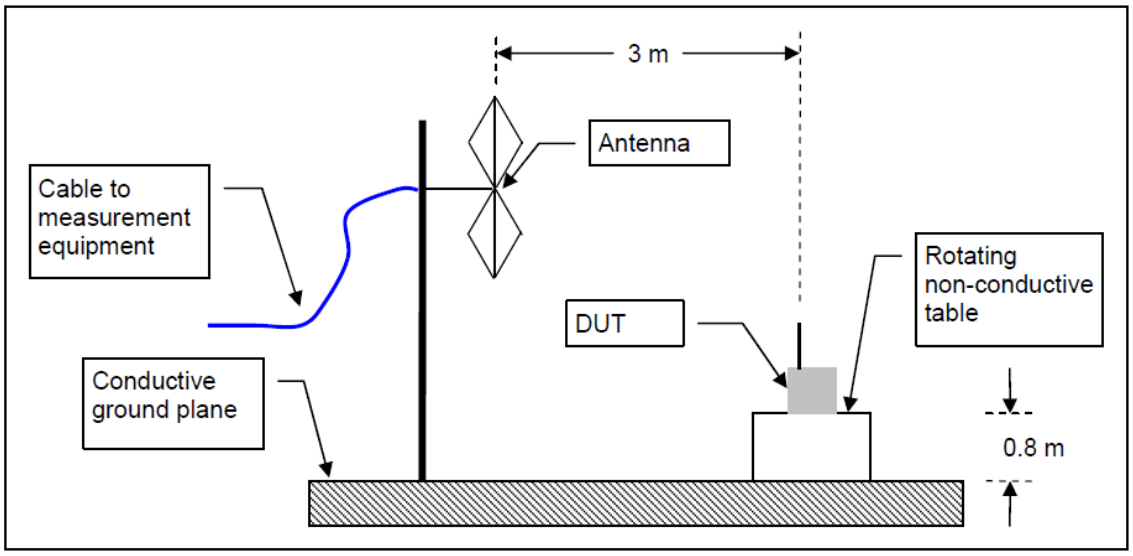
Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

4.6.2.3 Deviations

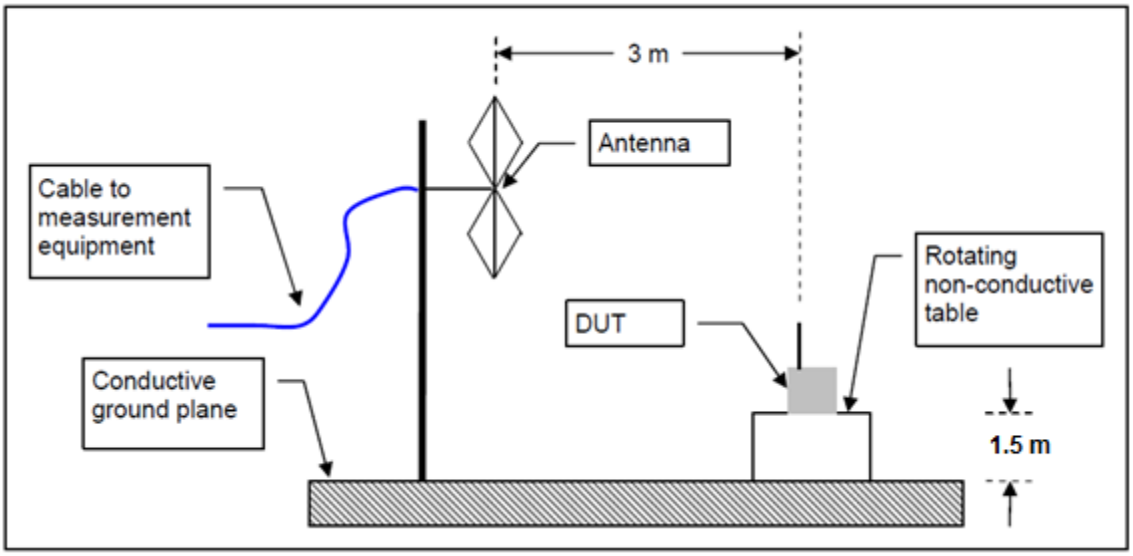
None.

4.6.3 Test Setup:

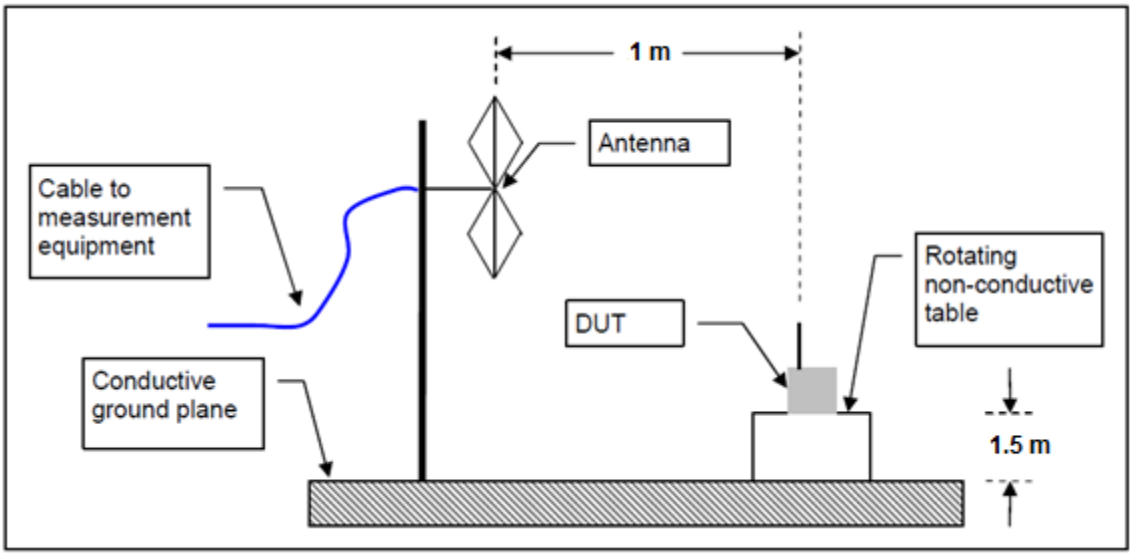
9KHz-1GHz



1-18GHz



18-40GHz



The DUT was stimulated by manufacturer provided test software that is not available to the end user.

4.6.4 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and test plan.

During measurements the EUT's LTE radio was also activated. For 30MHz-1GHz LTE band 4 was active and for all other measurements, LTE band 12 was active.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.6.4.1 Measurement Plots

Note: Plots depict worse case antenna polarization and EUT orientation.

4.6.4.1.1 UNII-1

4.6.4.1.1.1 802.11n Mode HT20

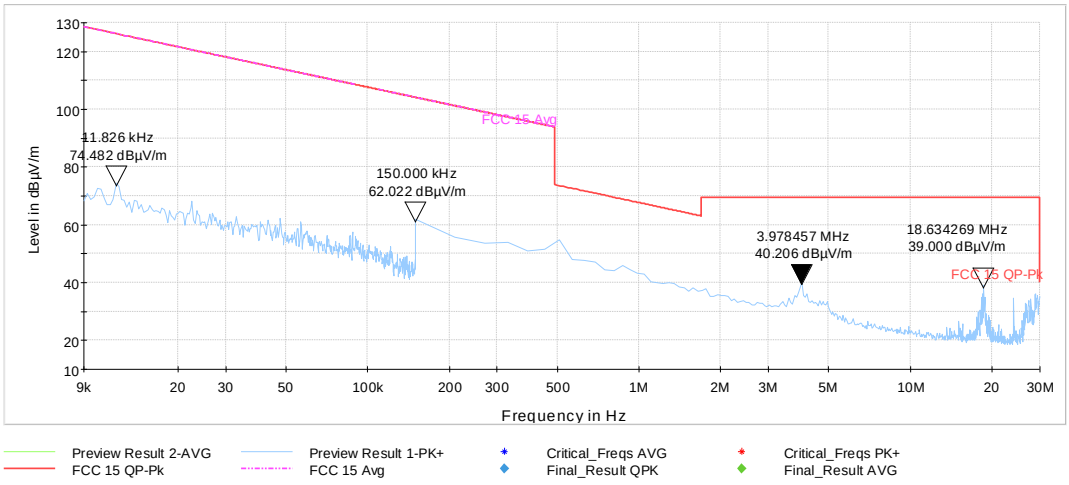


Figure 43: 9KHz-30MHz Channel 44

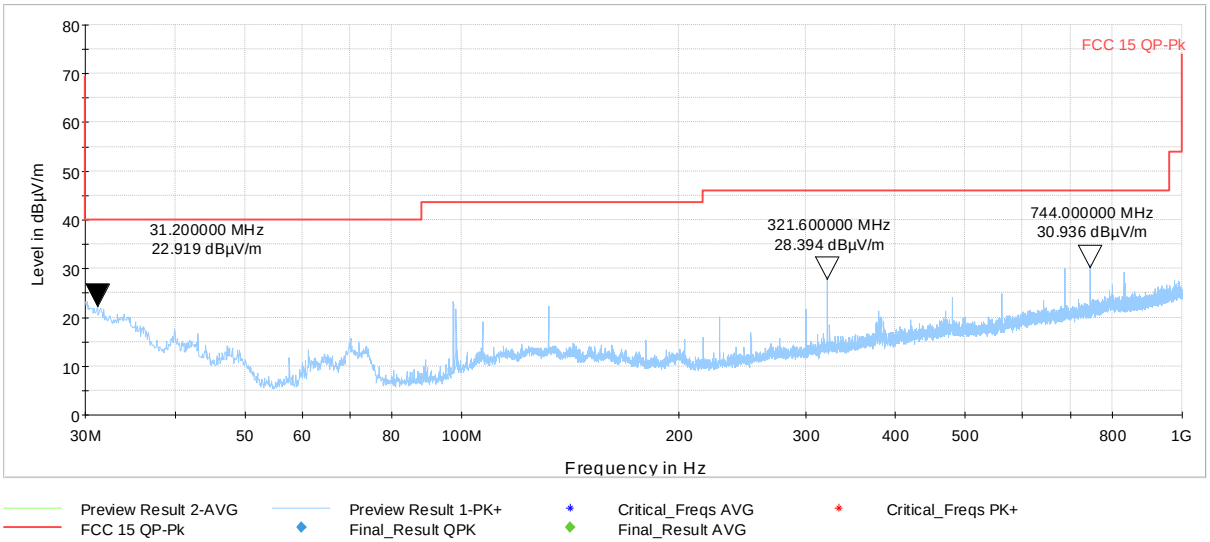


Figure 44: 30MHz-1GHz Channel 36

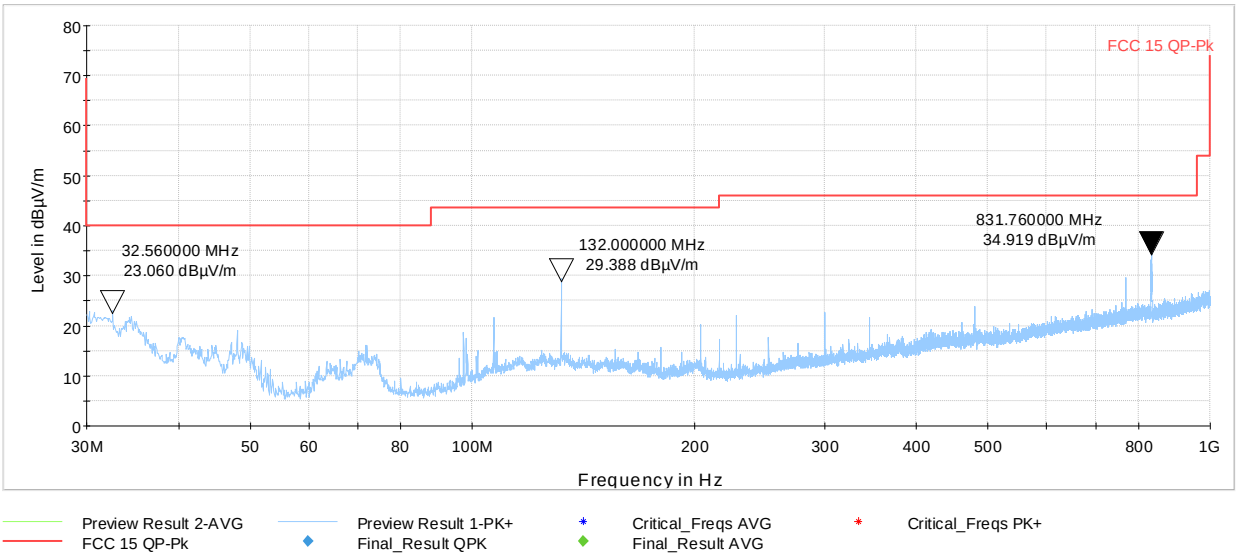


Figure 45: 30MHz-1GHz Channel 44

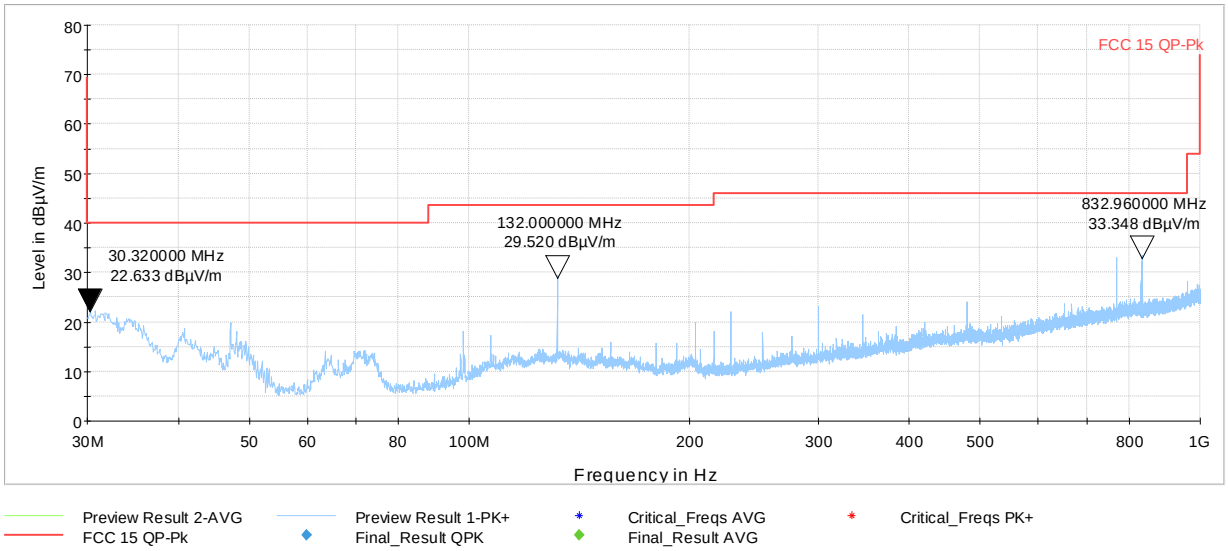


Figure 46: 30MHz-1GHz Channel 48

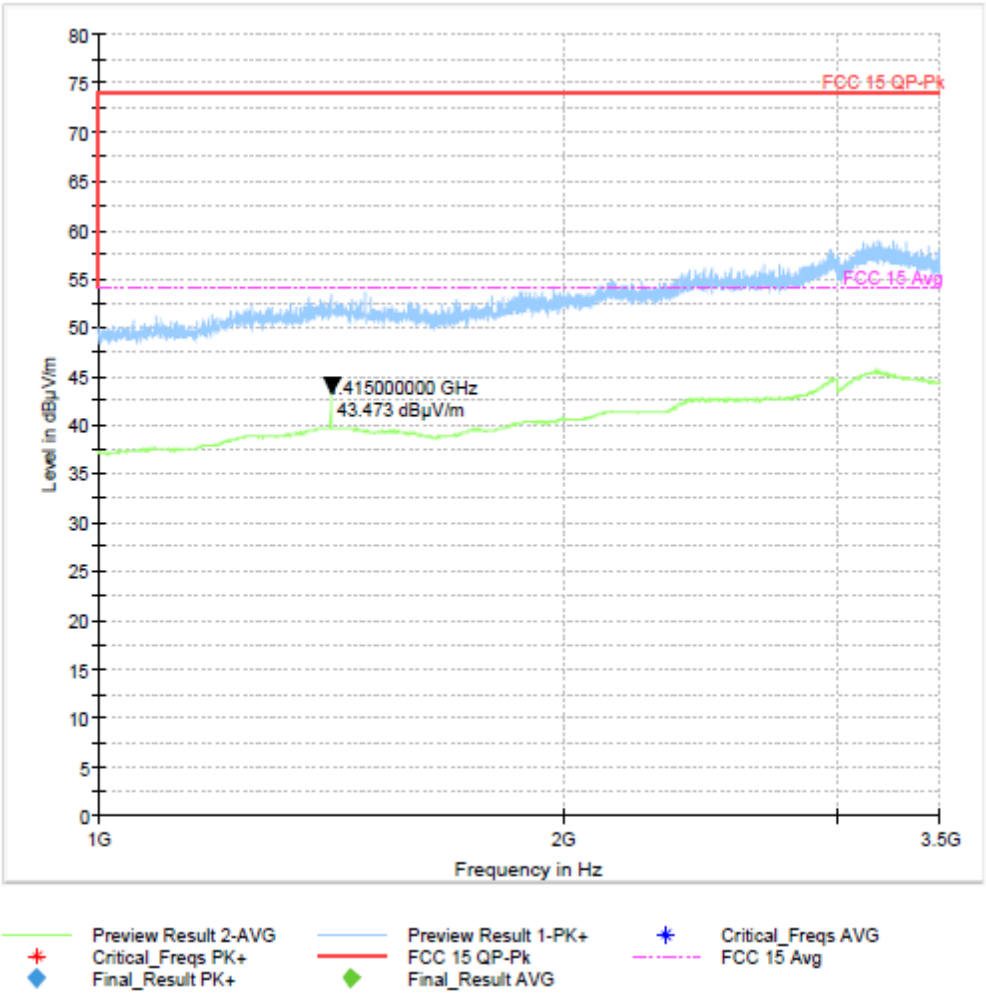


Figure 47: 1-3.5GHz Channel 36

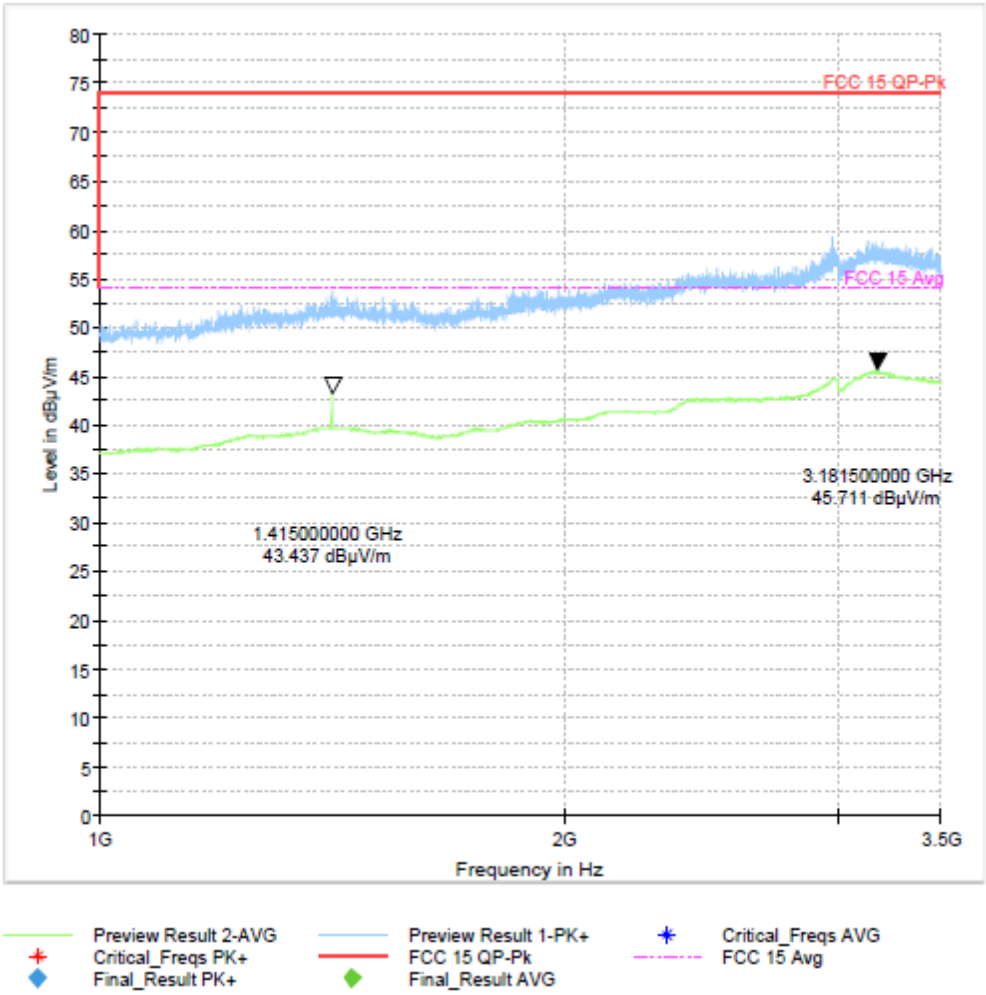


Figure 48: 1-3.5GHz Channel 44

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
1000.000000	50.22	---	54.00	23.78	500.0	1000.000	400.0	H	318.0	-75.0
1415.300000	---	45.20	54.00	8.80	500.0	1000.000	114.4	H	182.0	51.1

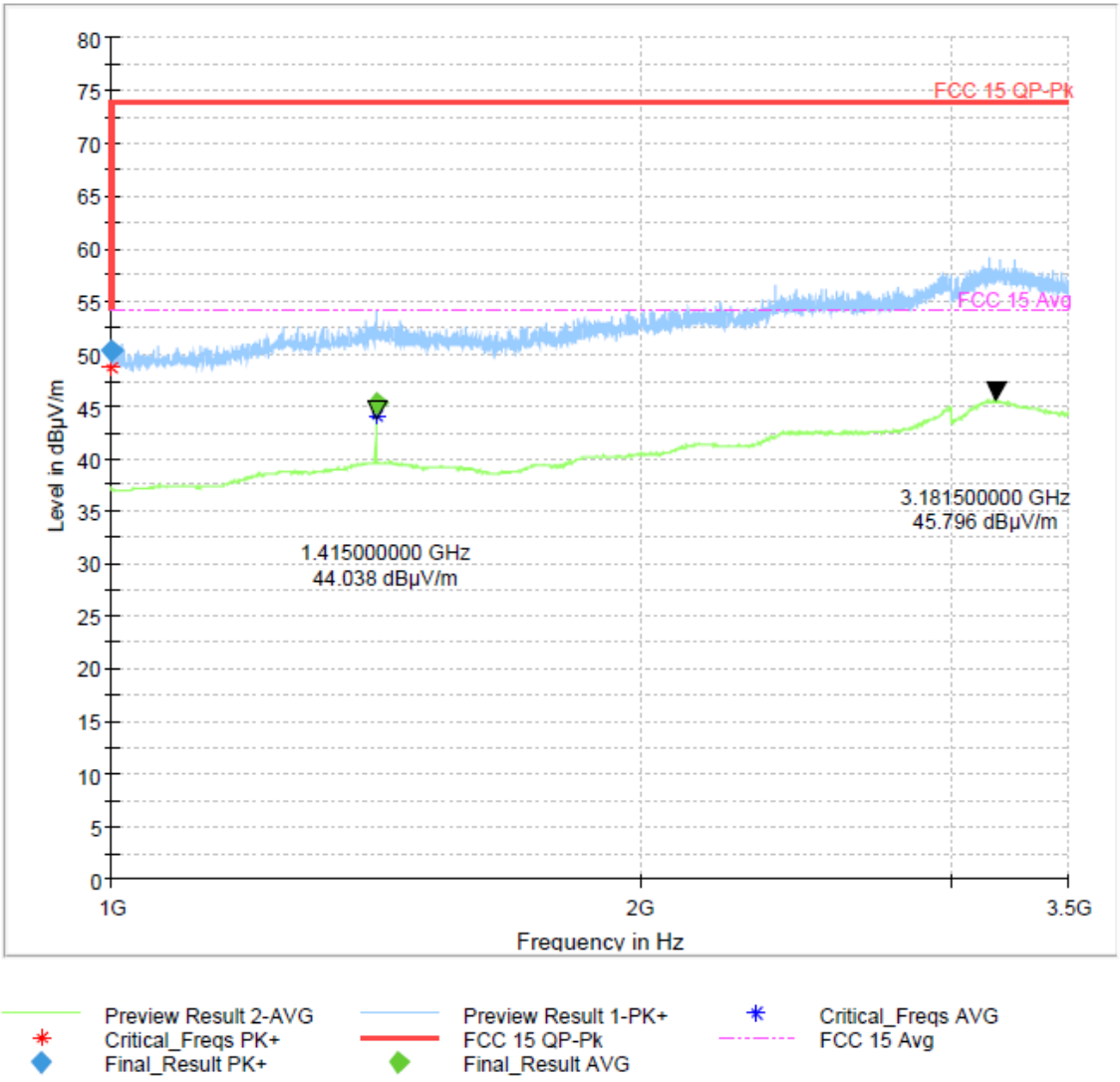
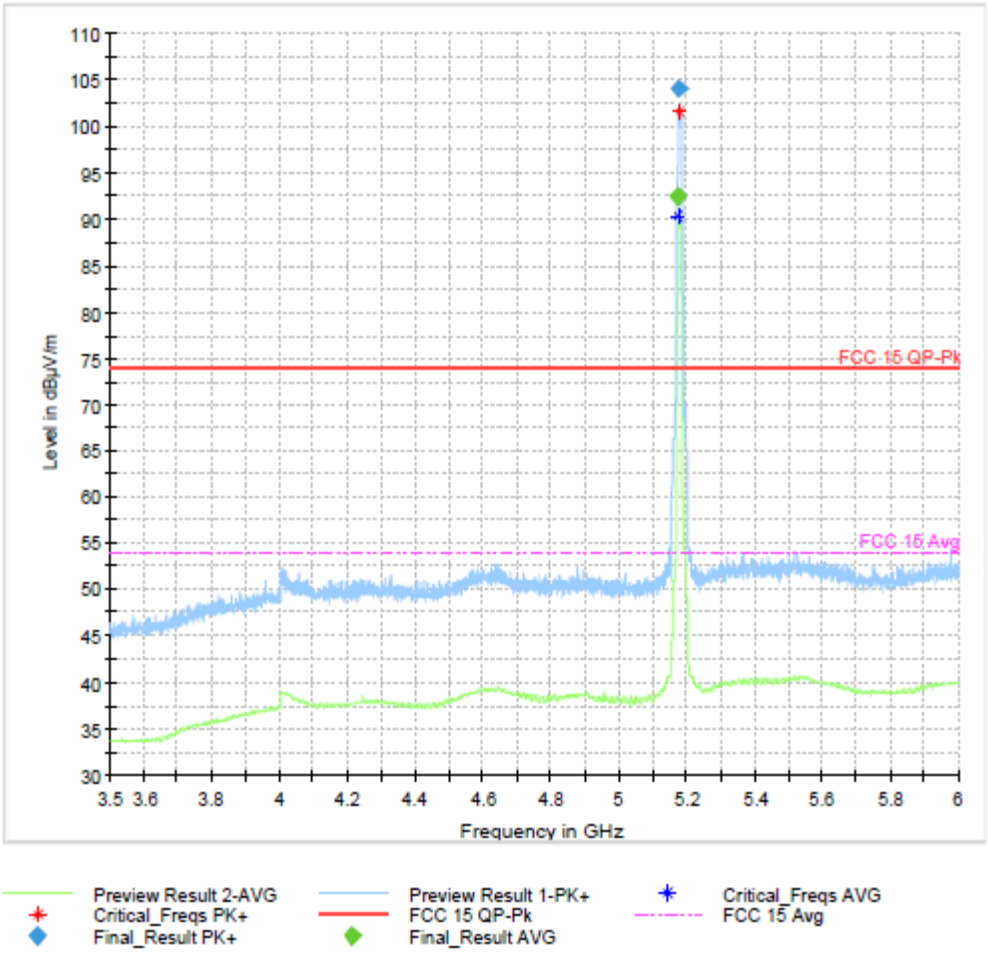
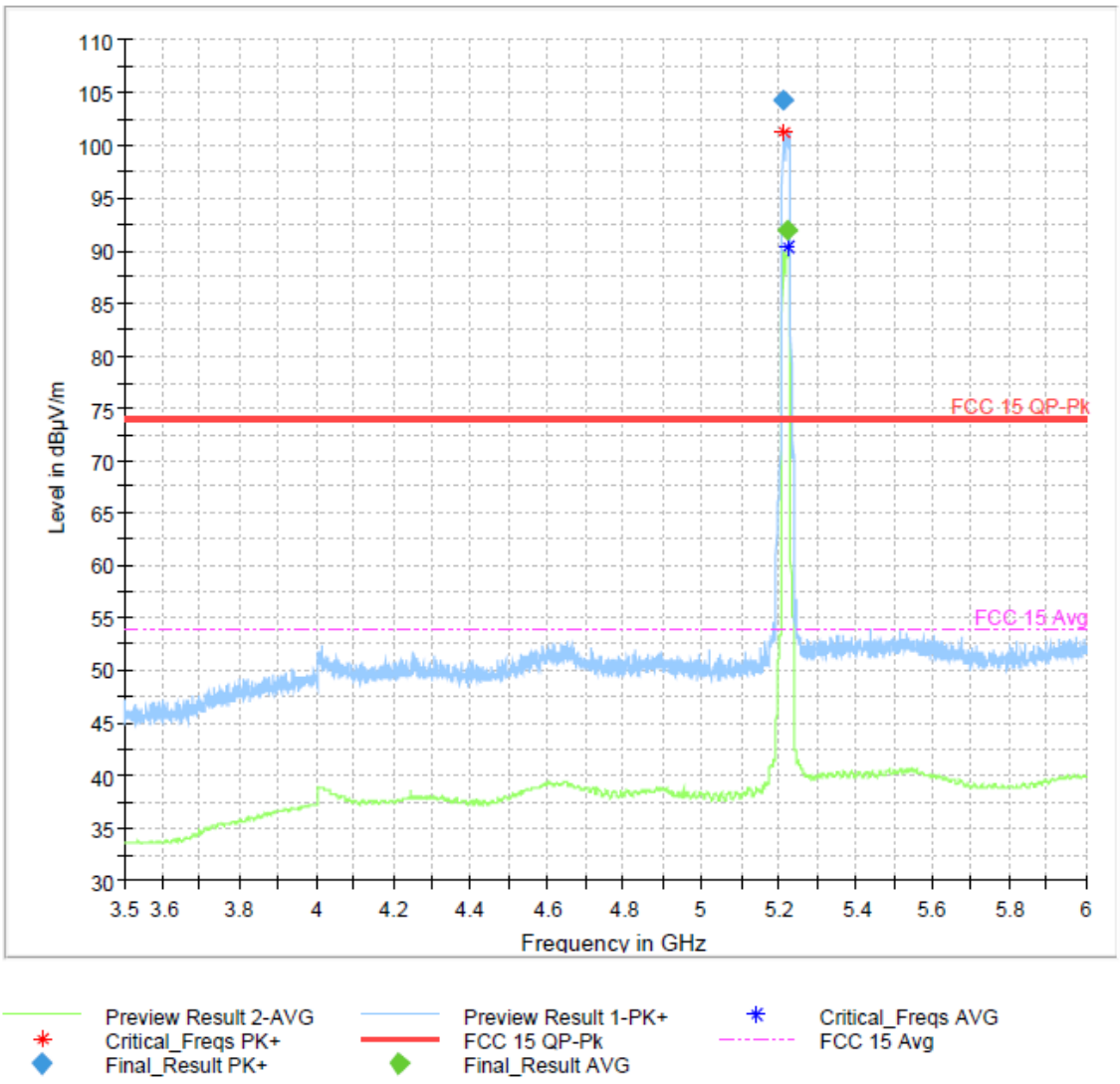


Figure 49: 1-3.5GHz Channel 48



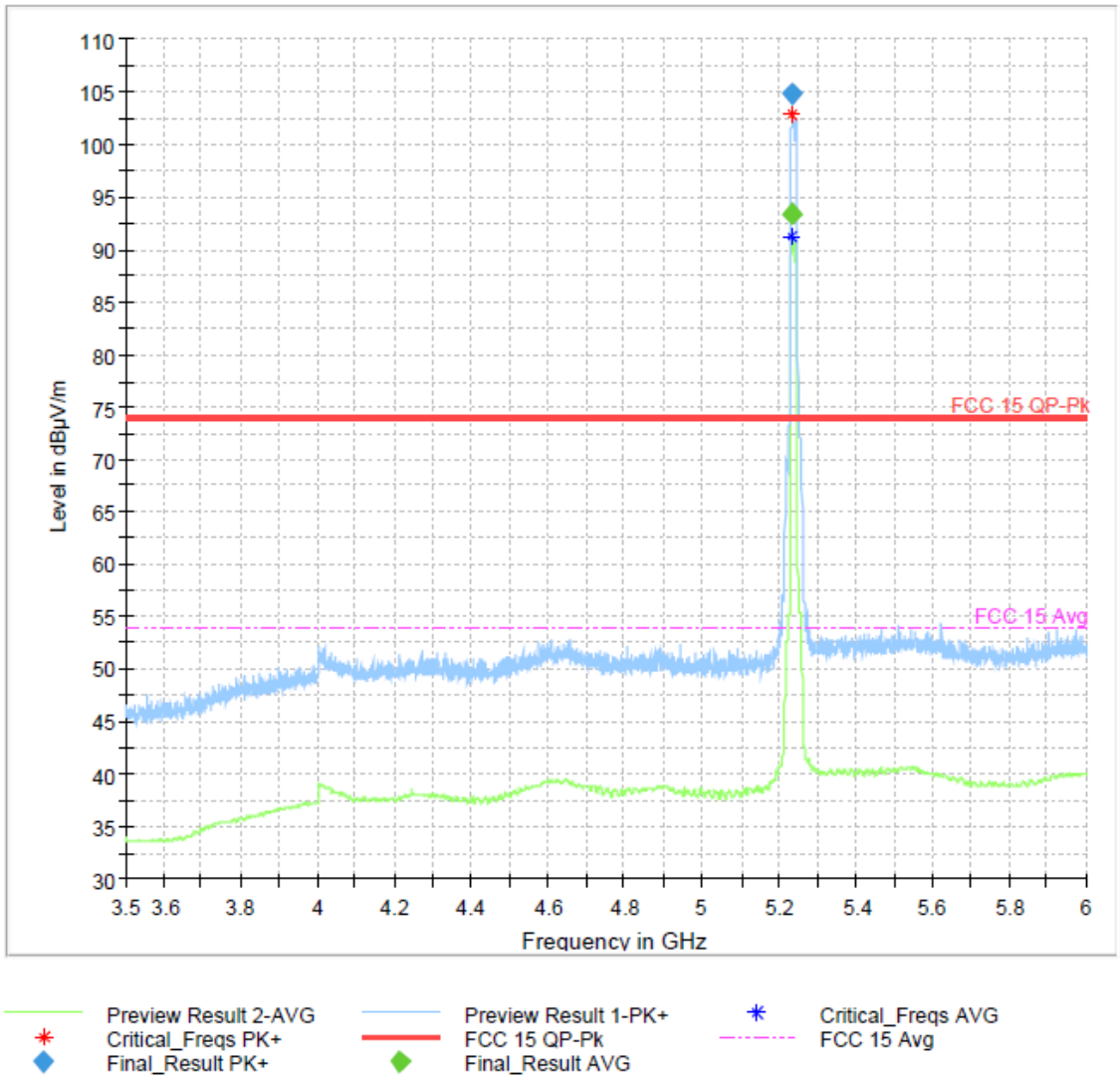
Note: Emission above limit is the Fundamental.

Figure 50: 3.5-6GHz Channel 36



Note: Emission above limit is the Fundamental.

Figure 51: 3.5-6GHz Channel 44



Note: Emission above limit is the Fundamental.

Figure 52: 3.5-6GHz Channel 48

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
6906.610000	---	51.36	54.00	2.64	500.0	1000.000	144.1	H	93.0	83.1

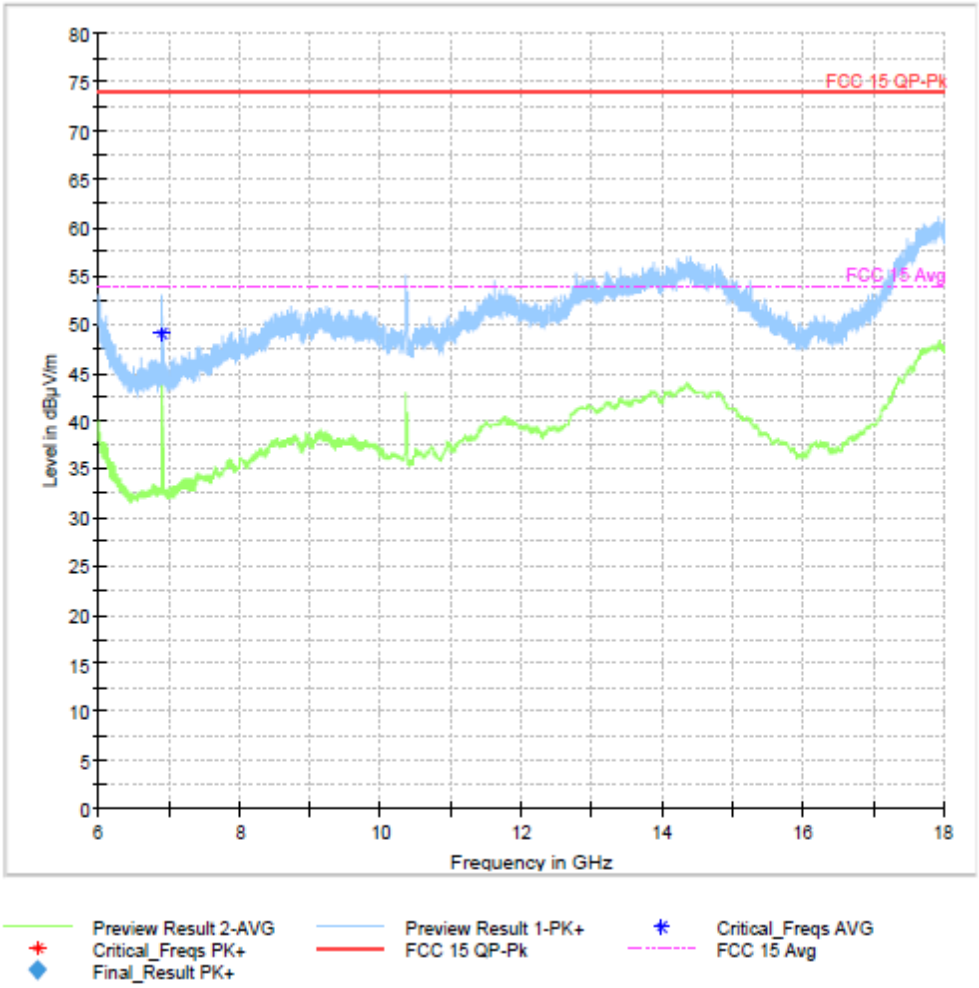


Figure 53: 6-18GHz Channel 36

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
6959.940000	---	51.92	54.00	2.08	500.0	1000.000	140.9	H	89.0	82.0
6959.950000	55.63	---	74.00	18.37	500.0	1000.000	140.3	H	91.0	81.1

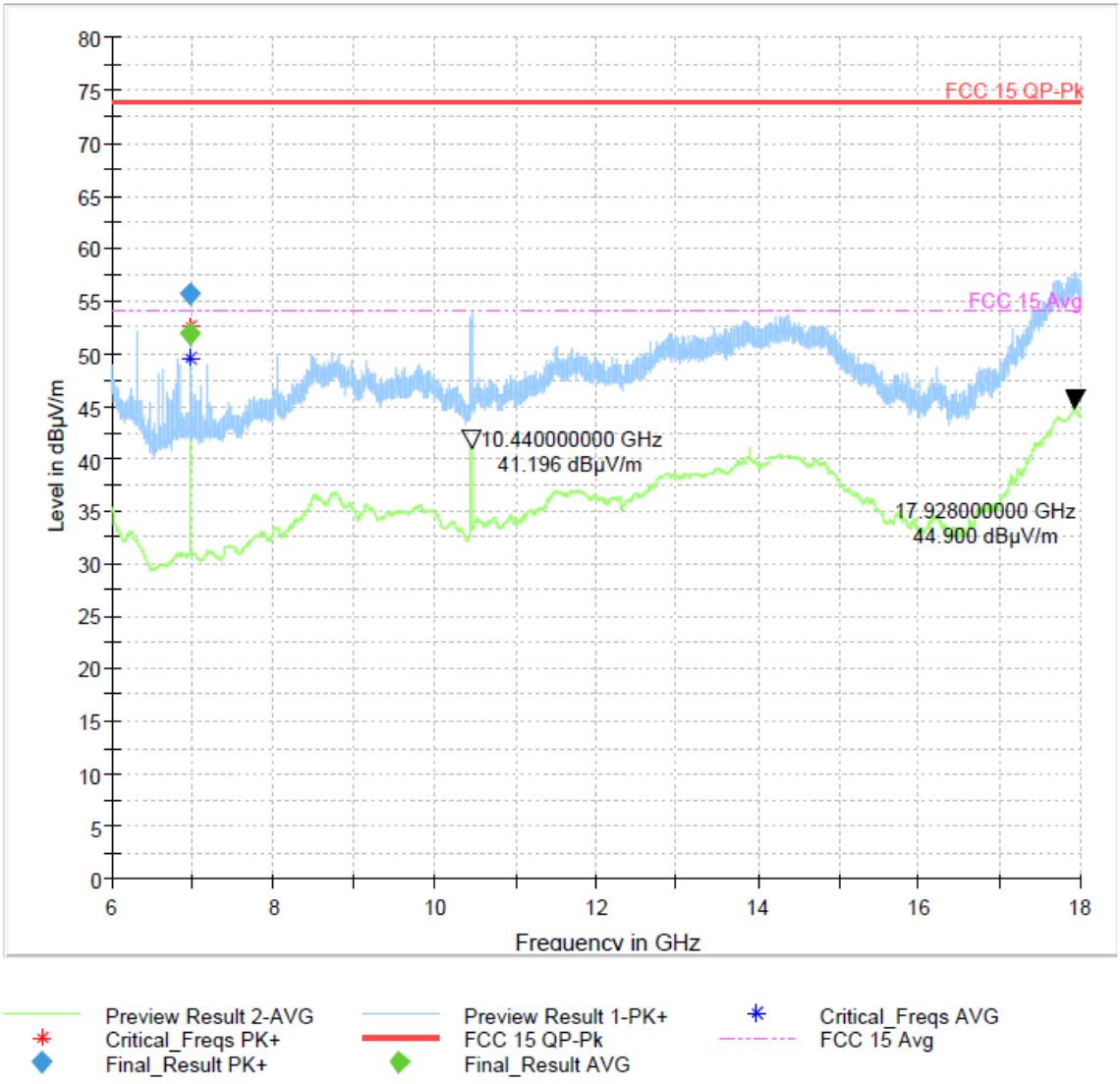


Figure 54: 6-18GHz Channel 44

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
6986.630000	---	51.77	54.00	2.23	500.0	1000.000	152.0	H	89.0	82.0
6986.670000	55.25	---	74.00	18.75	500.0	1000.000	151.5	H	90.0	82.0

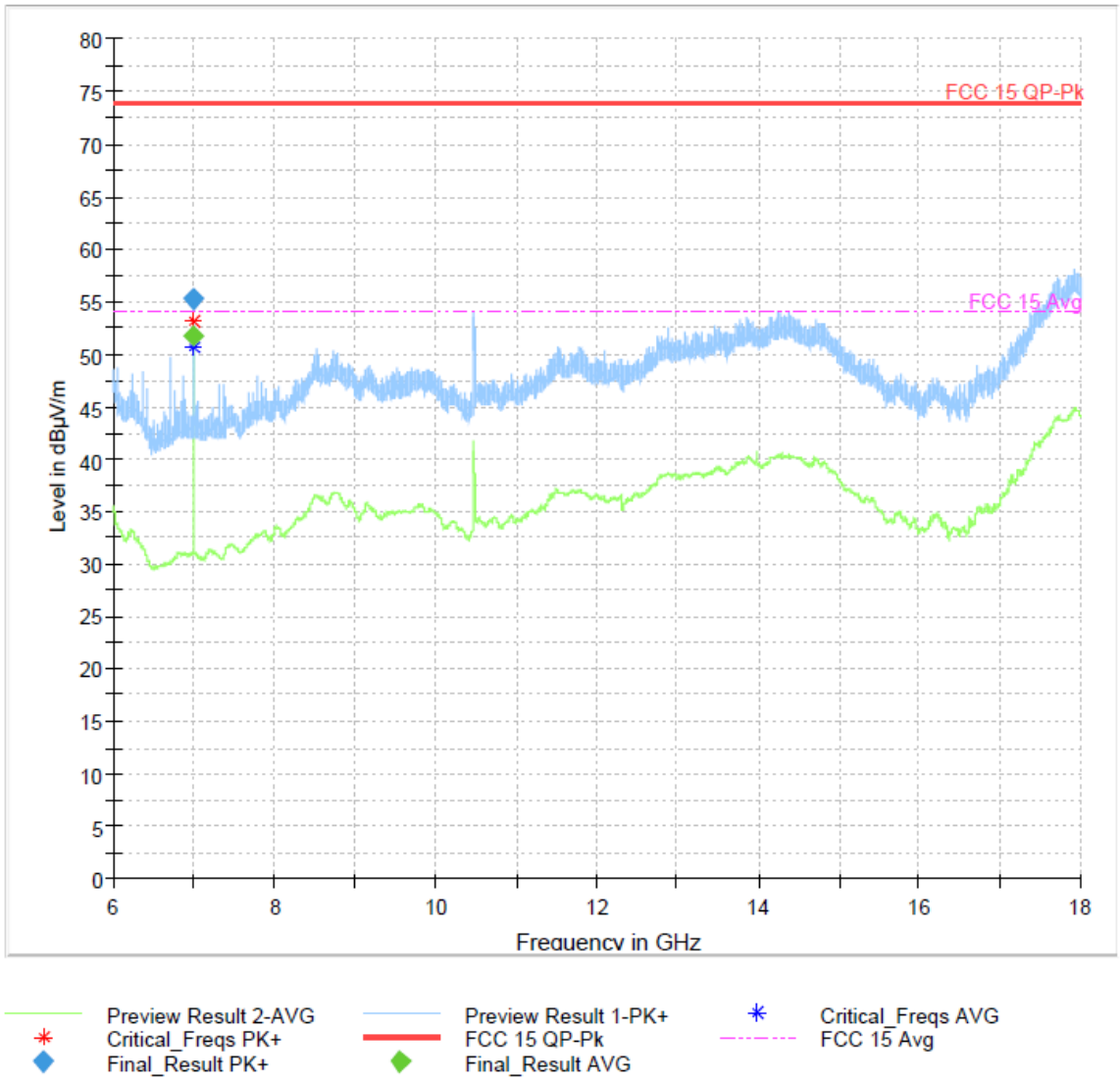


Figure 55: 6-18GHz Channel 48

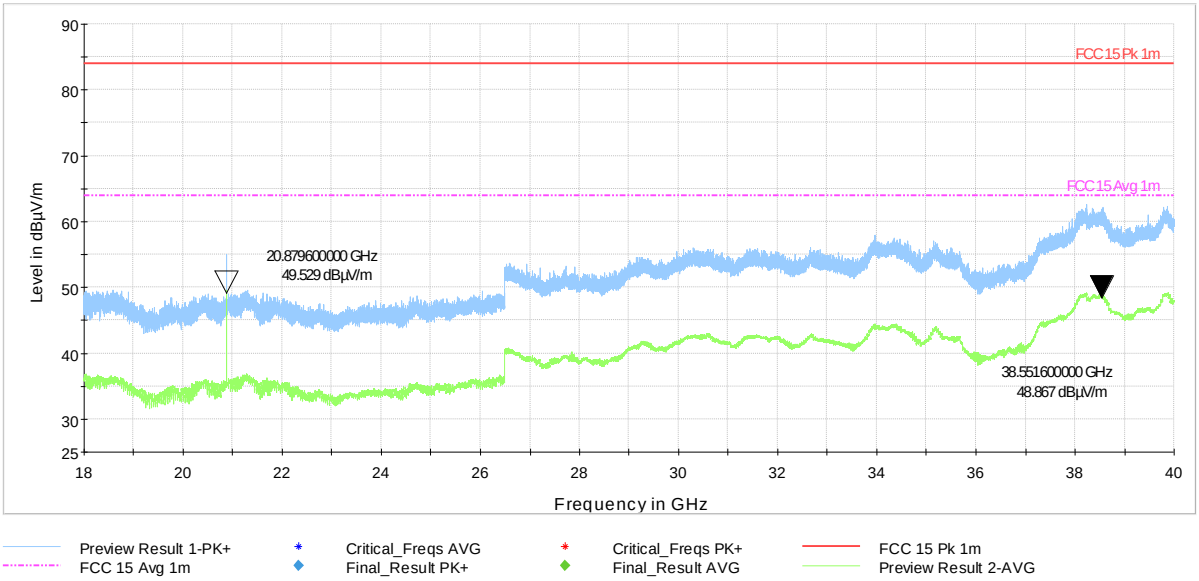


Figure 56: 18-40GHz Channel 44

4.6.4.1.1.2 802.11n HT40 Mode

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
6919.920000	---	51.03	54.00	2.97	500.0	1000.000	144.3	H	95.0	83.0
6920.120000	54.16	---	74.00	19.84	500.0	1000.000	130.3	H	94.0	83.1

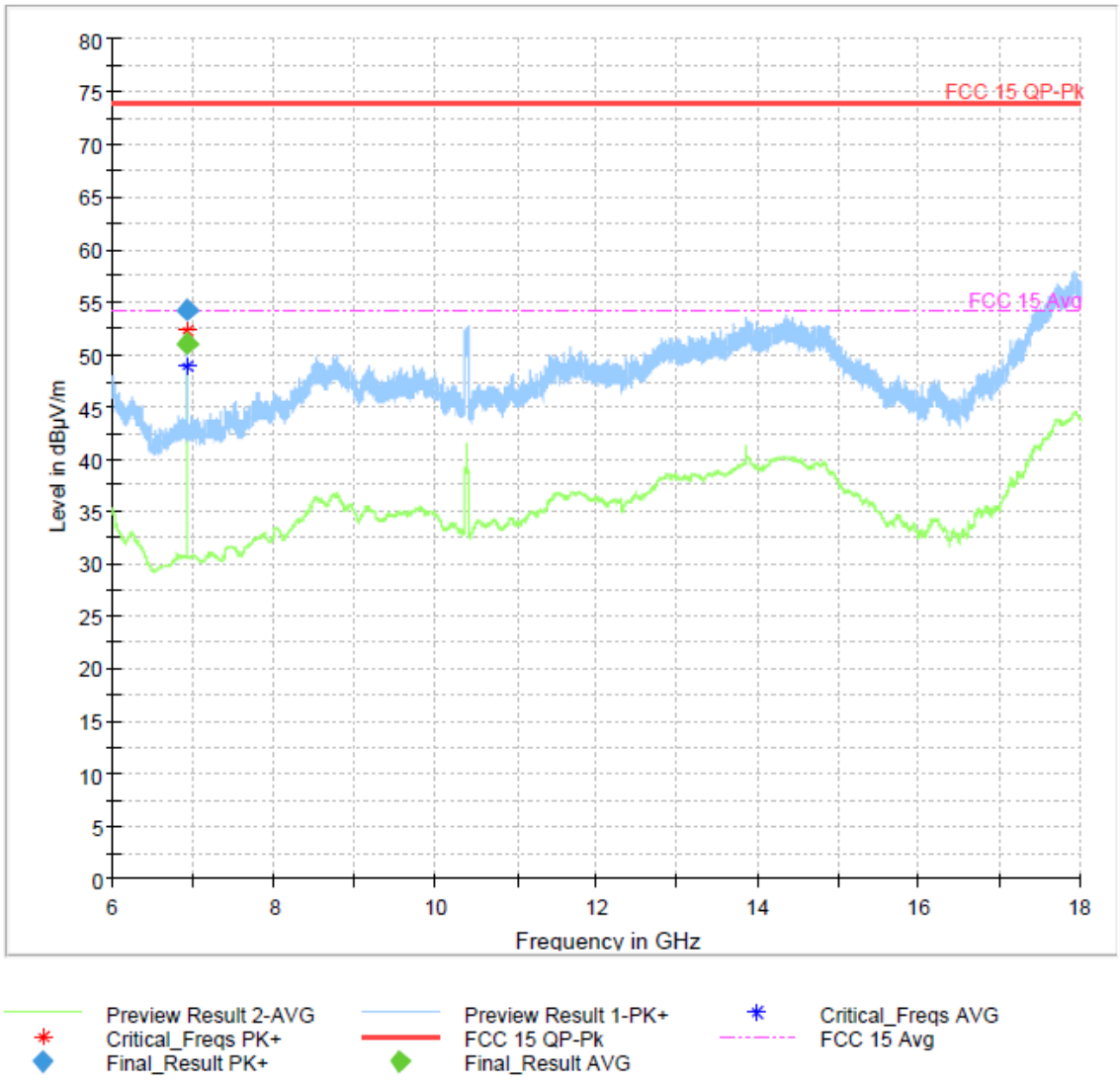


Figure 57: 6-18GHz Channel 38

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
6973.130000	54.27	---	74.00	19.73	500.0	1000.000	160.9	H	95.0	85.0
6973.280000	---	51.41	54.00	2.59	500.0	1000.000	136.7	H	89.0	83.0

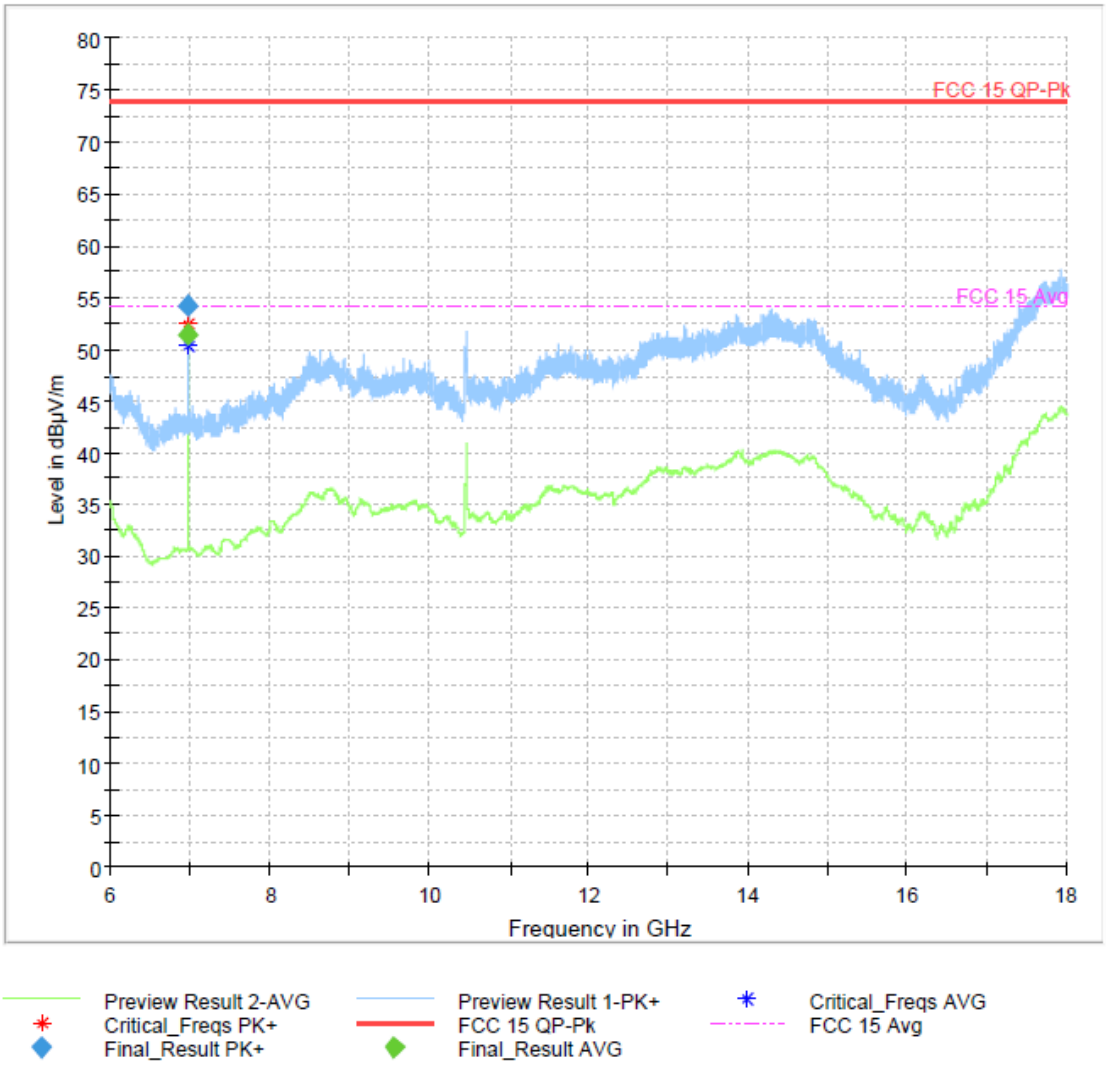


Figure 58: 6-18GHz Channel 46

4.6.4.1.1.3 802.11ac VHT80 Mode

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
6946.580000	54.98	---	74.00	19.02	500.0	1000.000	148.1	H	89.0	82.0
6946.610000	---	51.44	54.00	2.56	500.0	1000.000	142.9	H	88.0	82.0

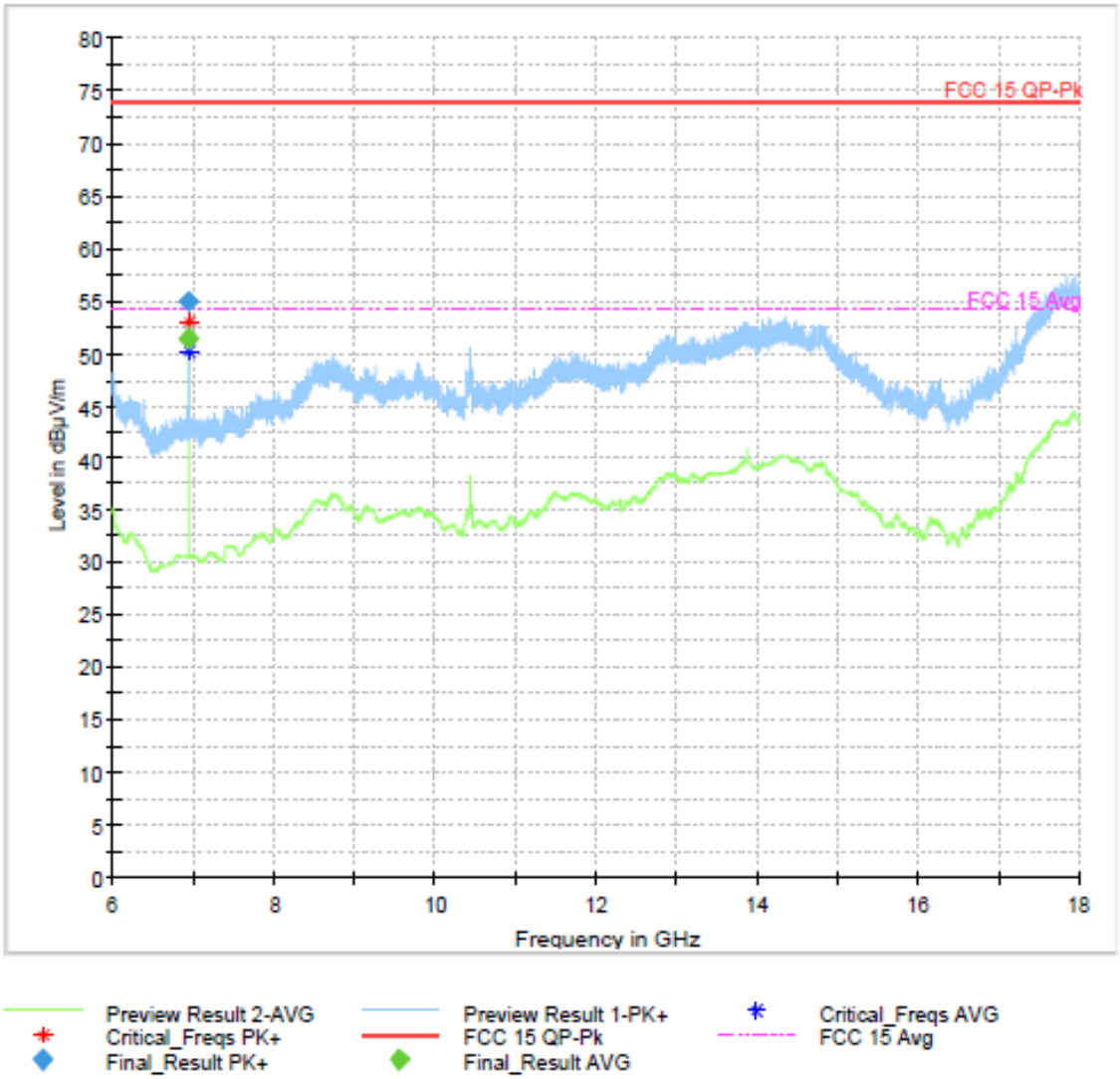


Figure 59: 6-18GHz Channel 42

4.6.4.1.2 UNII-3

4.6.4.1.2.1 802.11n Mode HT20

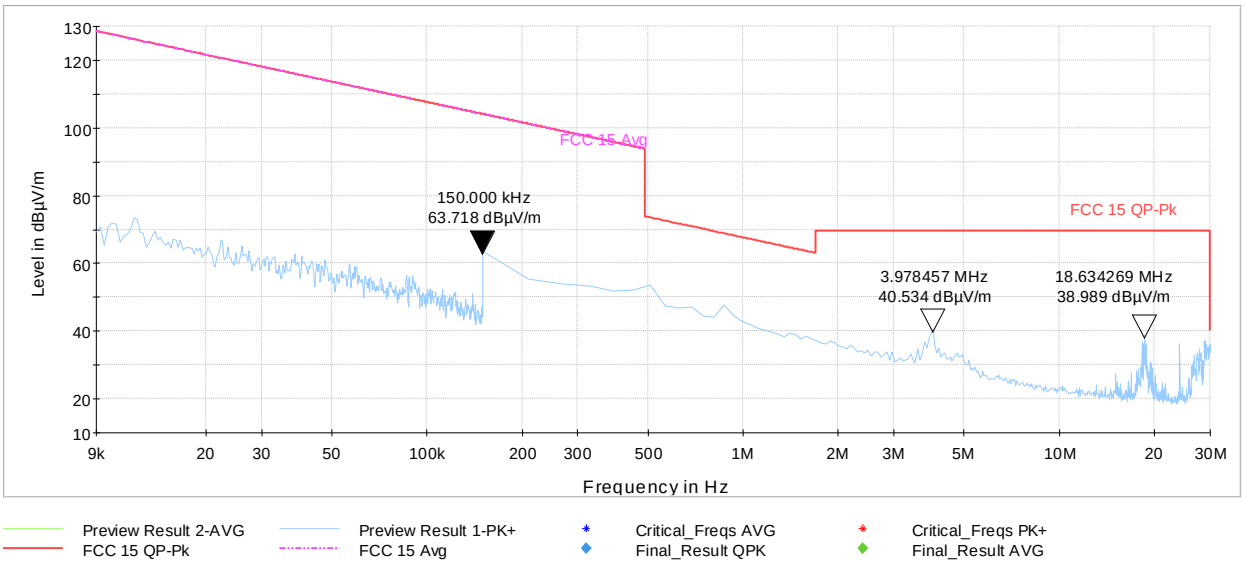


Figure 60: 9KHz-30MHz Channel 157

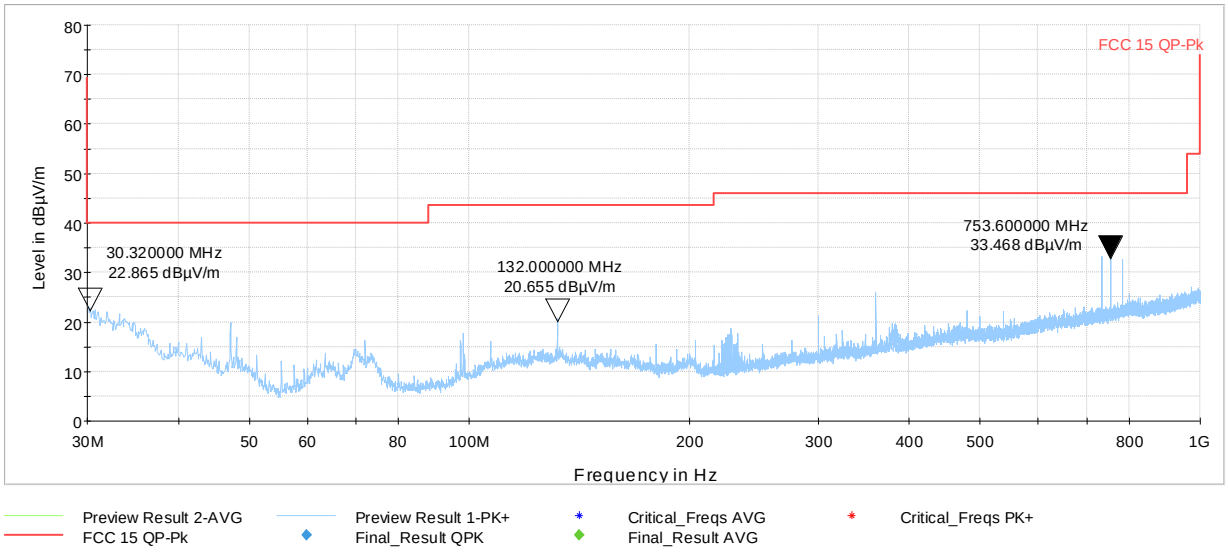


Figure 61: 30MHz-1GHz Channel 149

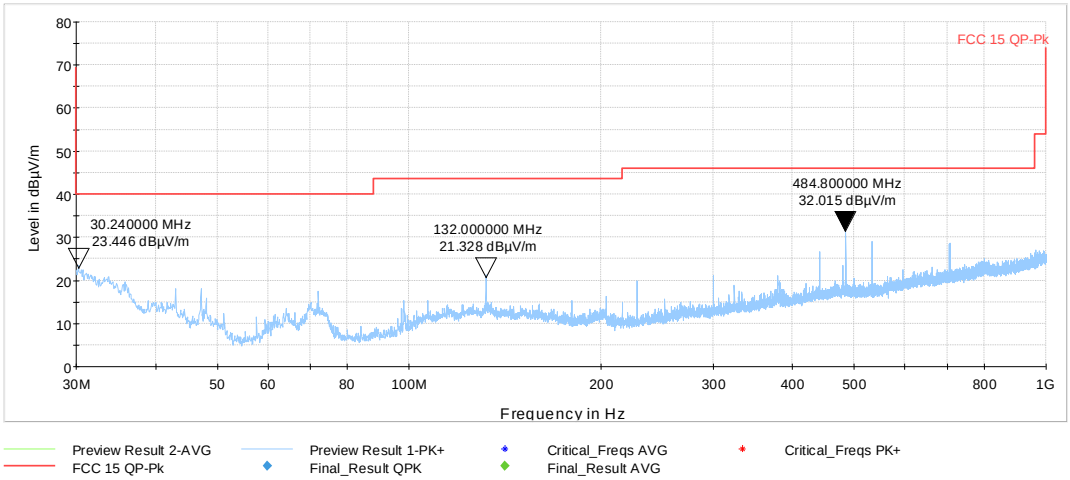


Figure 62: 30MHz-1GHz Channel 157

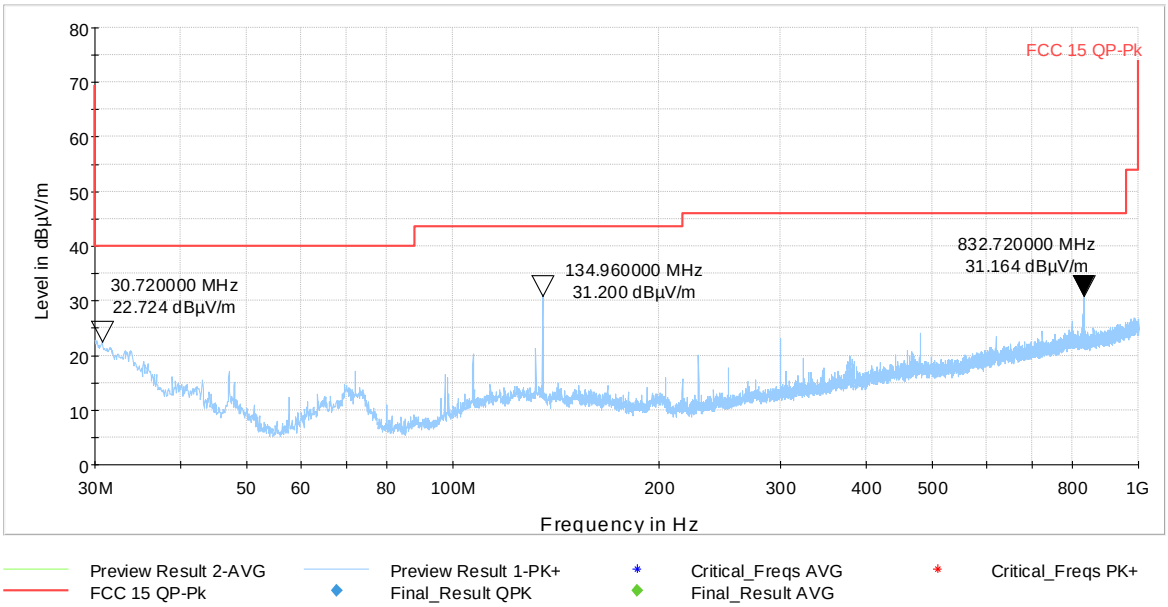


Figure 63: 30MHz-1GHz Channel 165

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
1415.310000	---	45.31	54.00	8.69	500.0	1000.000	153.7	H	187.0	55.0

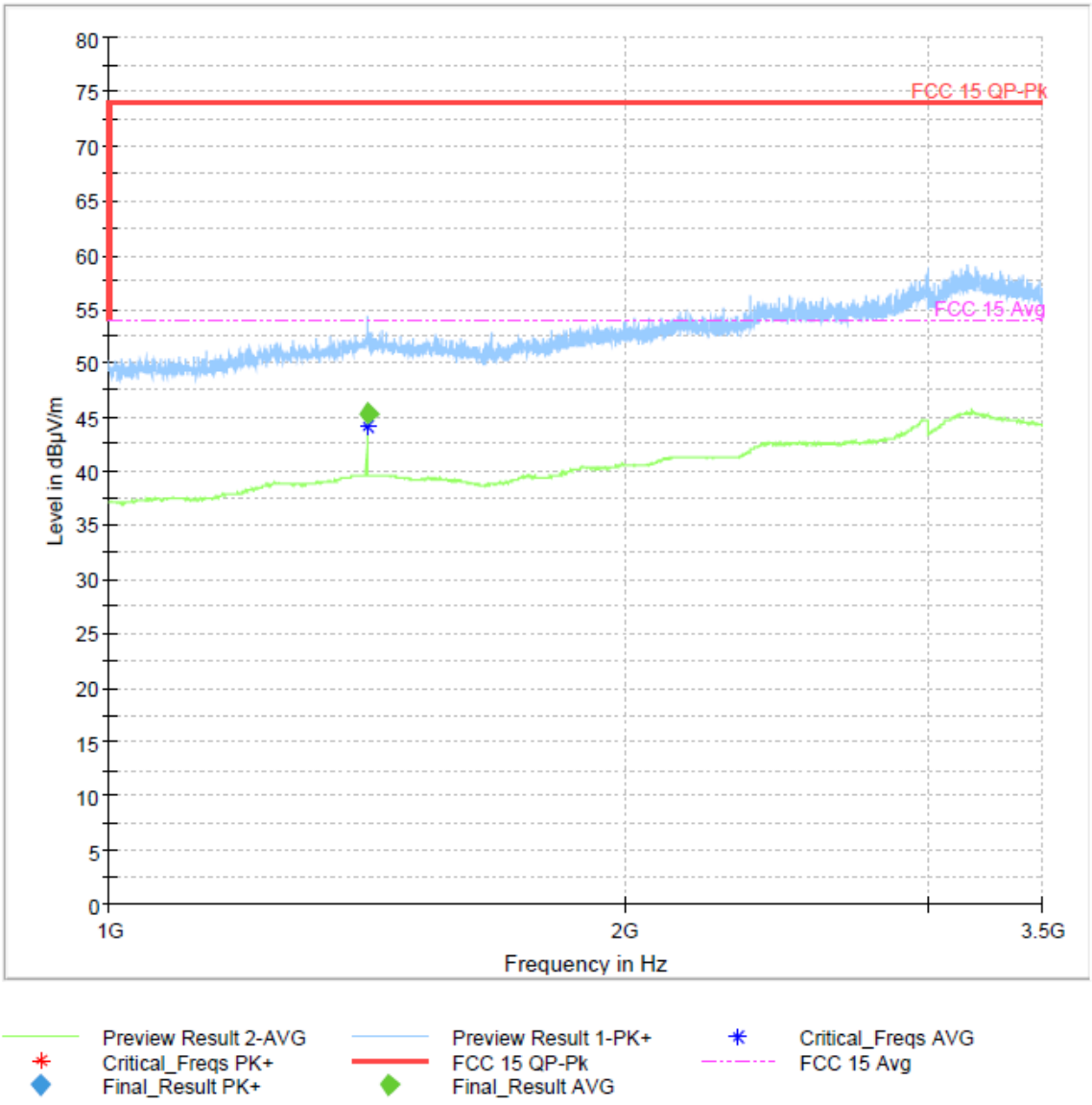


Figure 64: 1-3.5GHz Channel 149

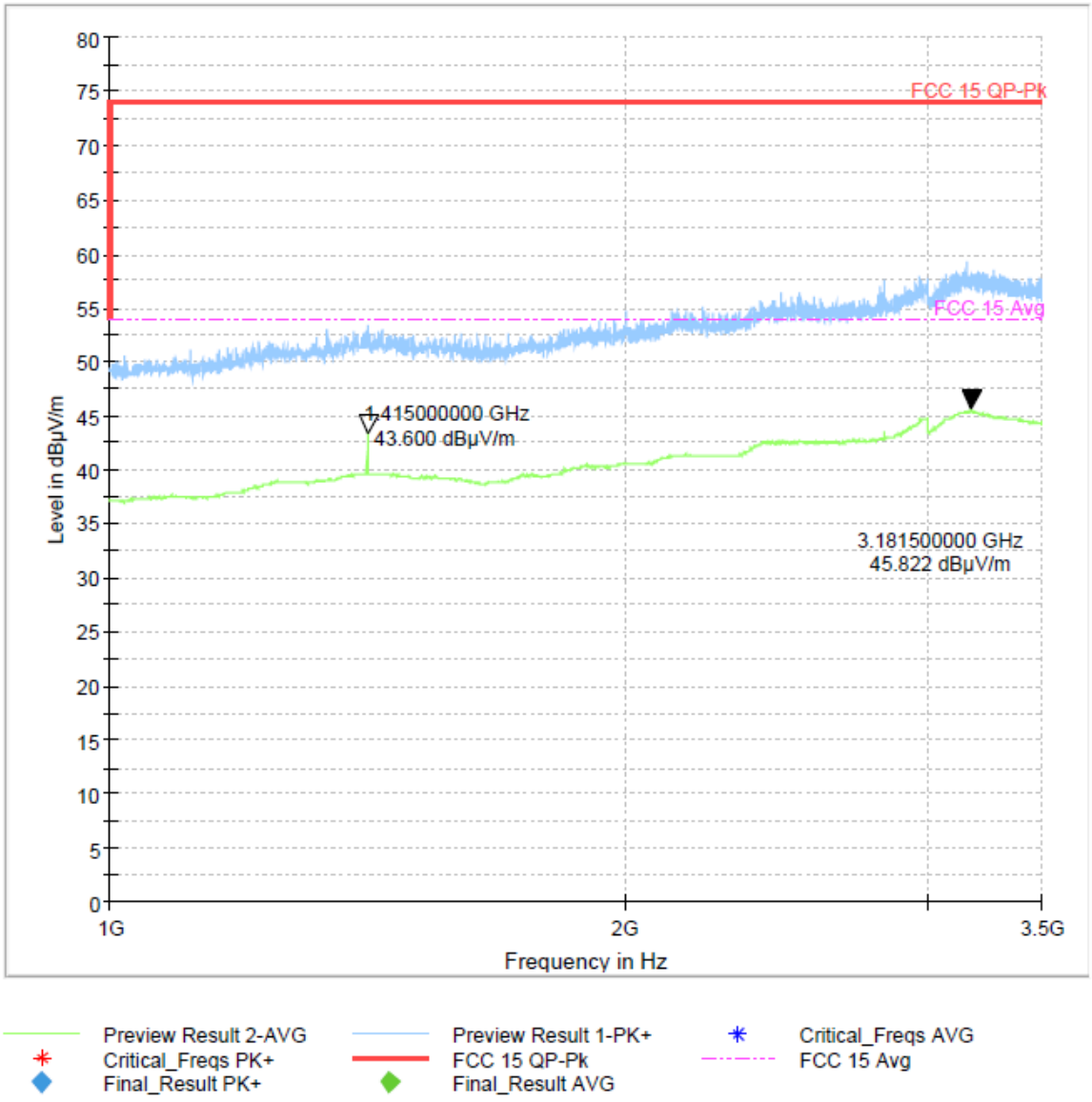


Figure 65: 1-3.5GHz Channel 157

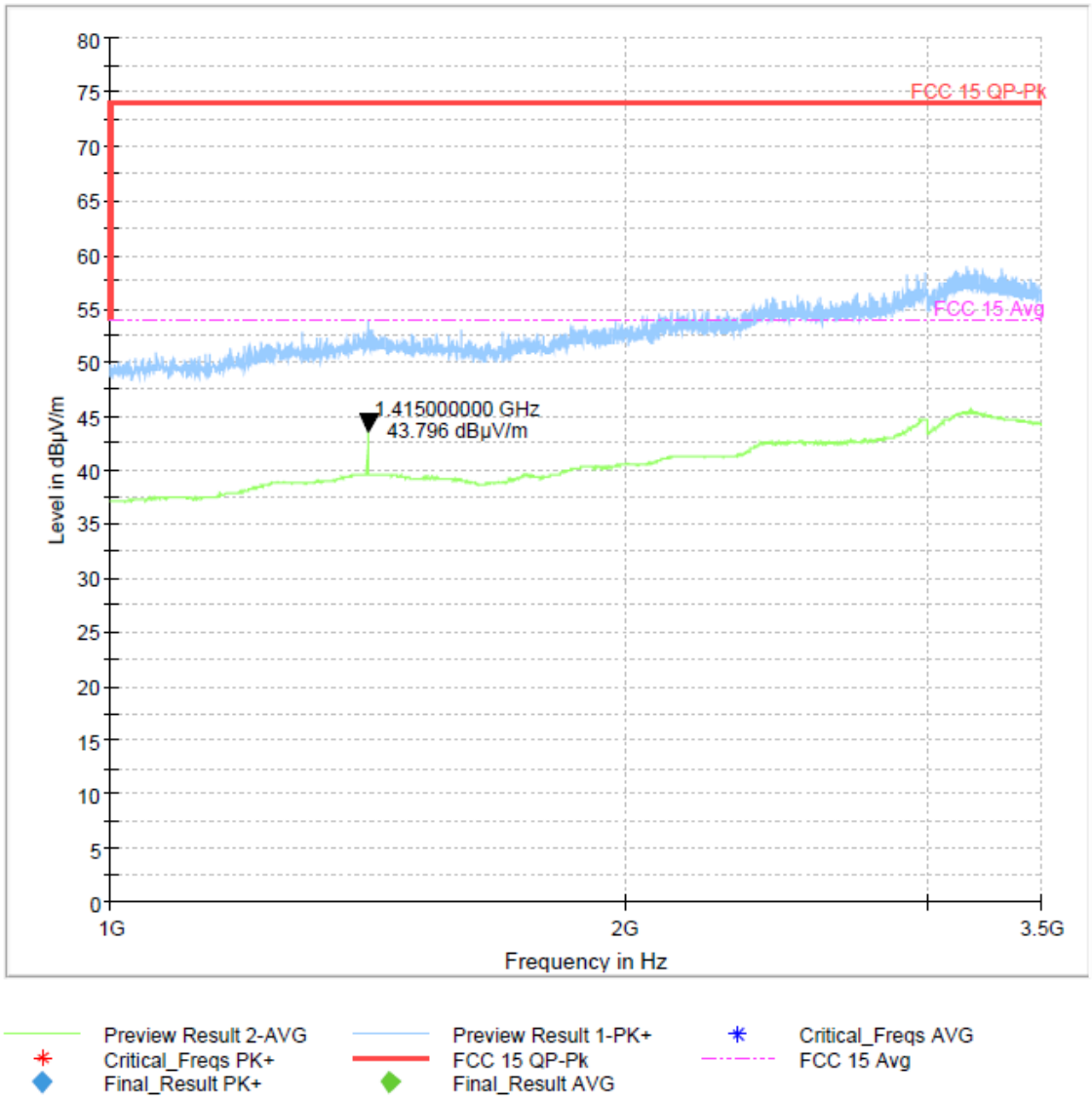
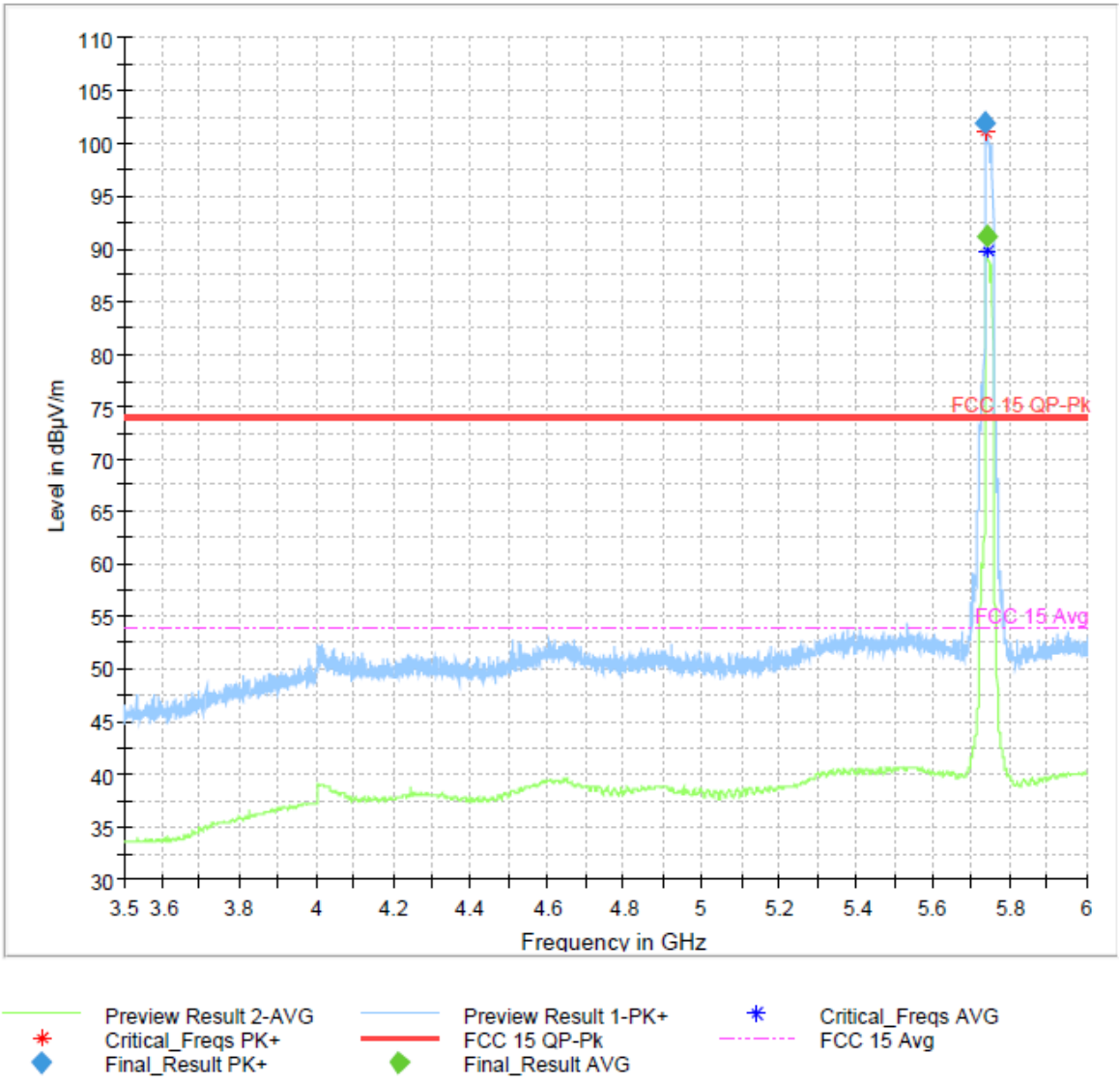
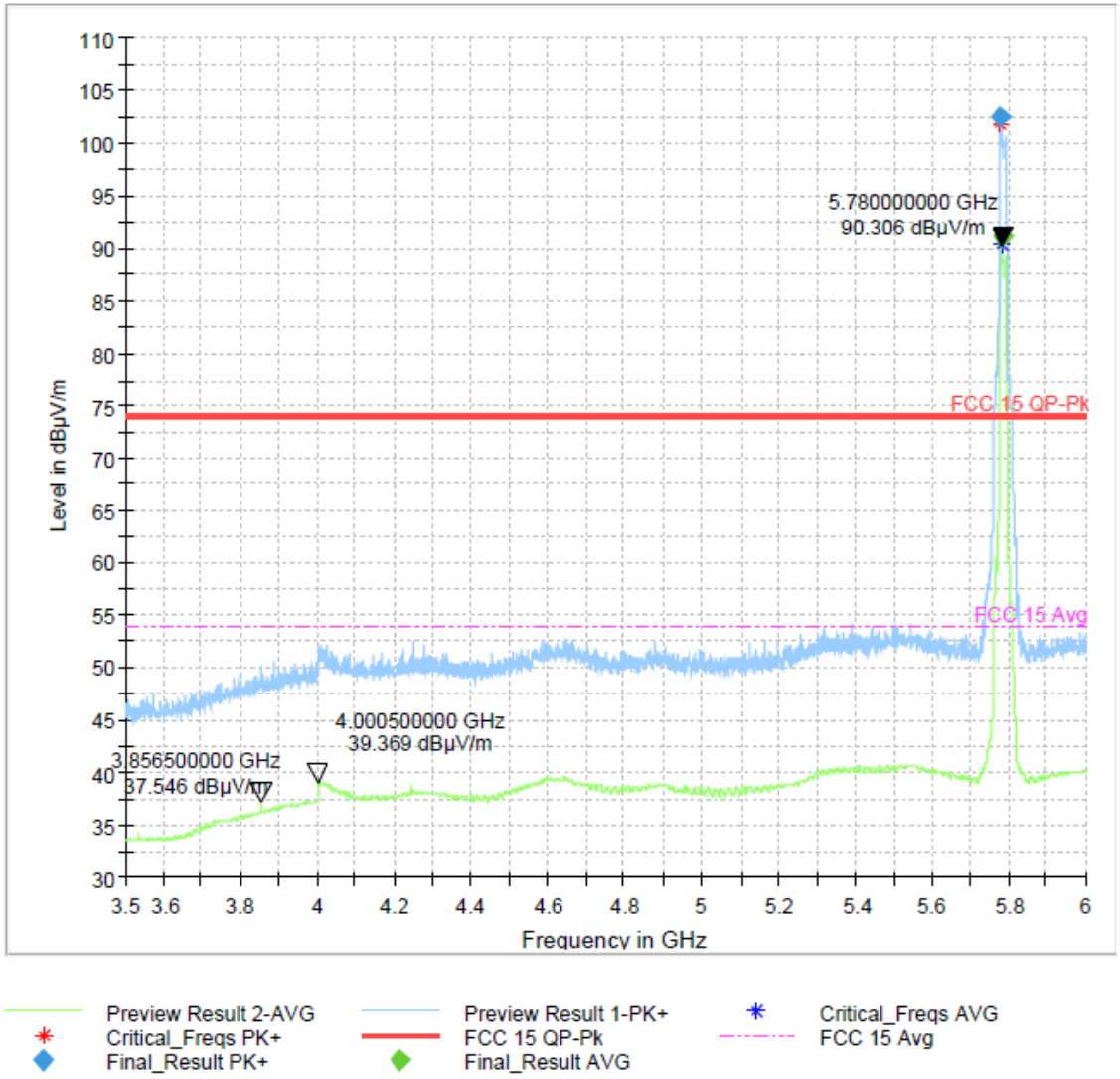


Figure 66: 1-3.5GHz Channel 165



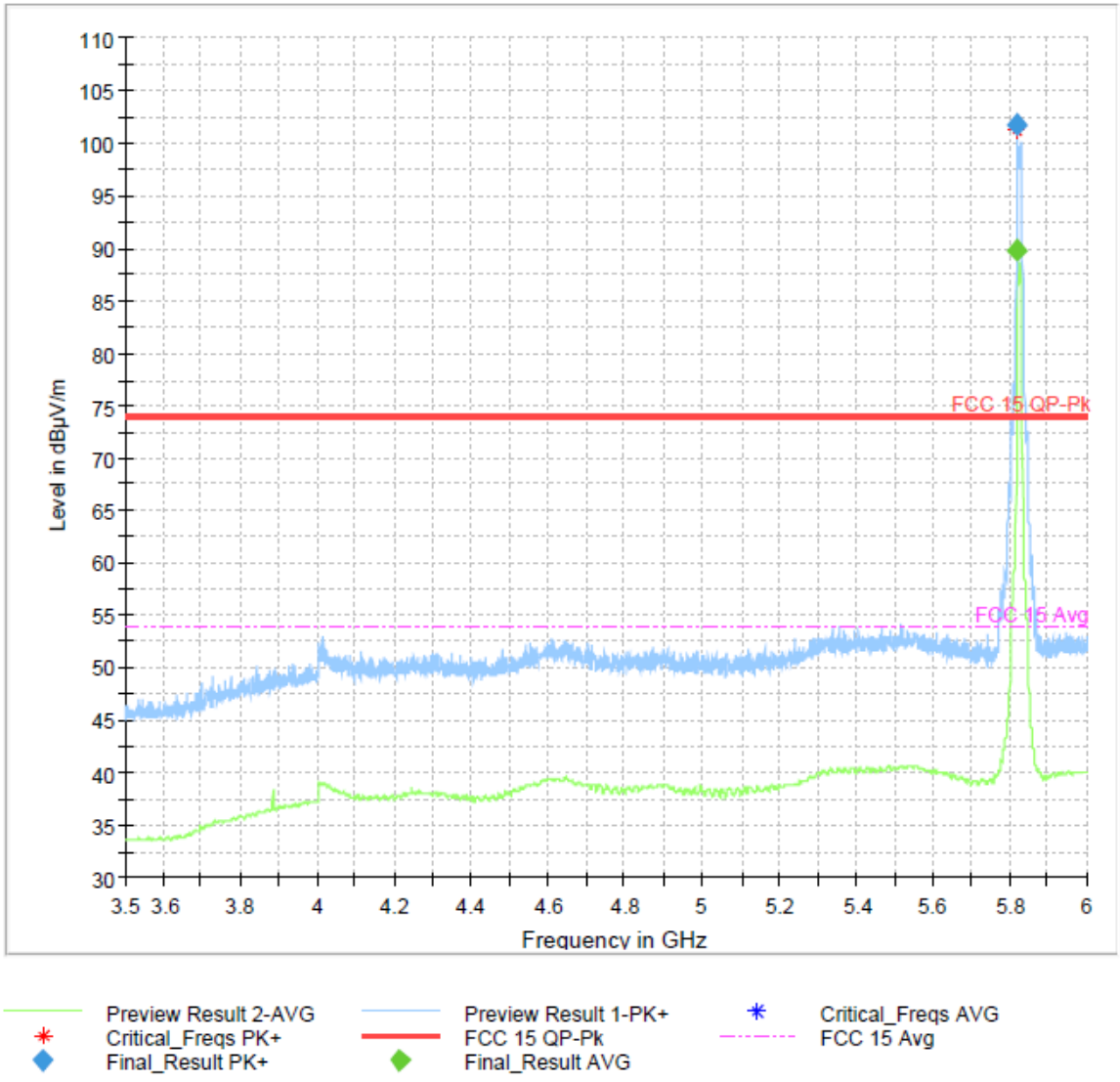
Note: Emission above limit is fundamental

Figure 67: 3.5-6GHz Channel 149



Note: Emission above limit is fundamental

Figure 68: 3.5-6GHz Channel 157



Note: Emission above limit is fundamental

Figure 69: 3.5-6GHz Channel 165

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
11490.050000	---	47.89	54.00	6.11	500.0	1000.000	154.2	H	41.0	97.0

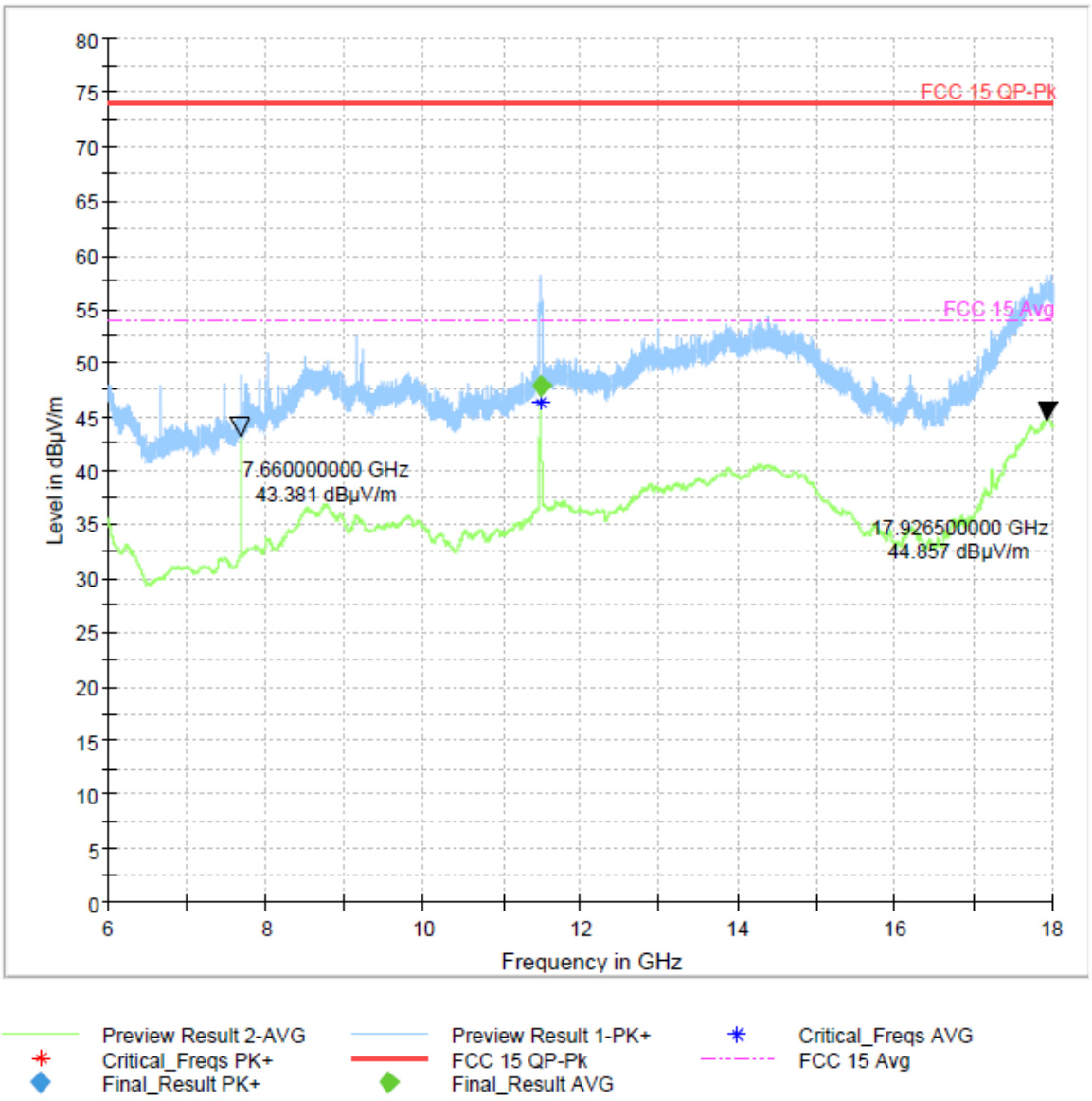


Figure 70: 6-18GHz Channel 149

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
7713.270000	---	50.78	54.00	3.22	500.0	1000.000	126.7	H	243.0	-62.0
11569.970000	---	49.47	54.00	4.53	500.0	1000.000	172.0	H	102.0	103.0

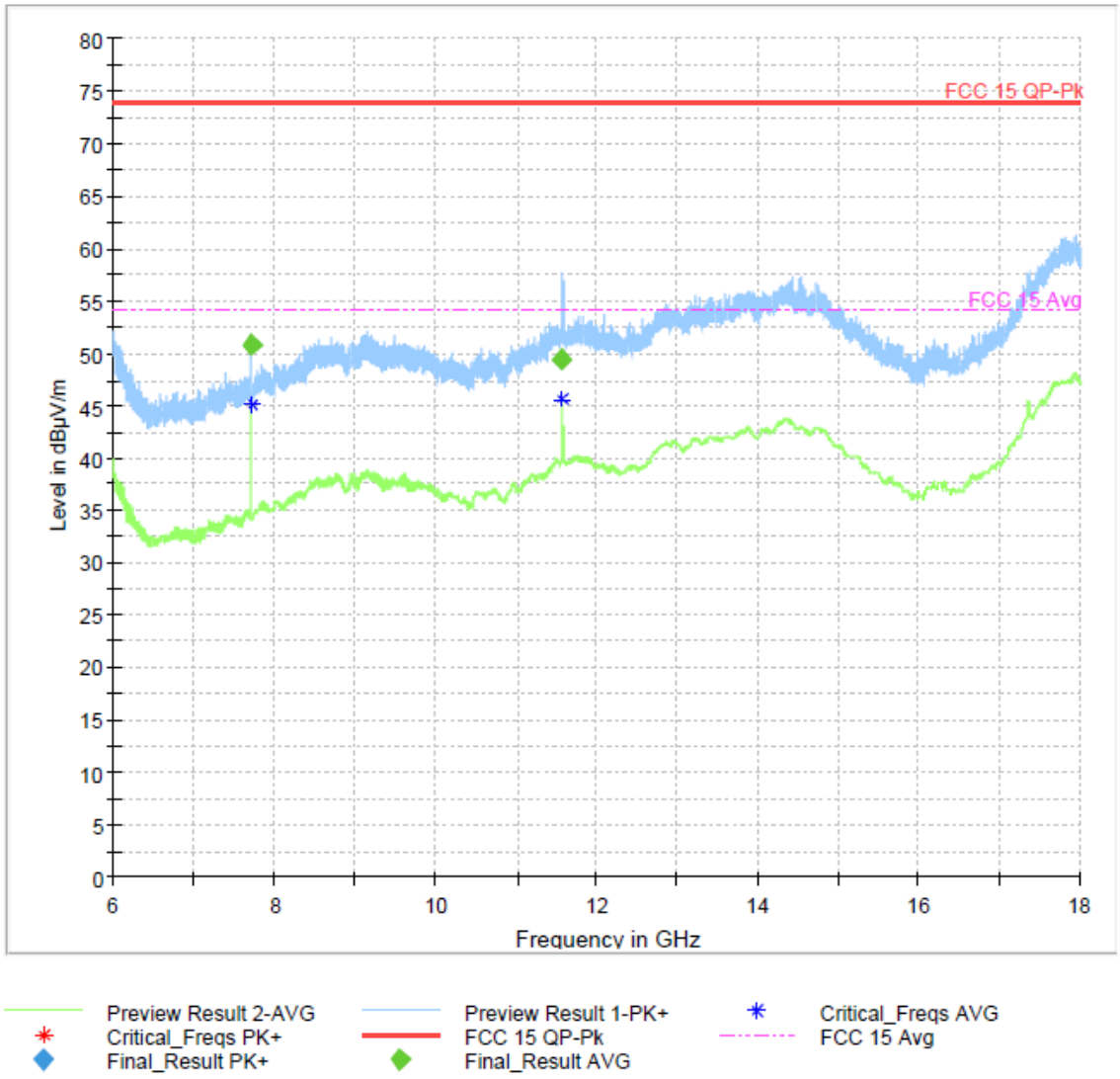


Figure 71: 6-18GHz Channel 157

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
7766.650000	---	51.25	54.00	2.75	500.0	1000.000	135.0	H	244.0	-64.0
11649.710000	---	49.49	54.00	4.51	500.0	1000.000	138.1	H	88.0	102.0

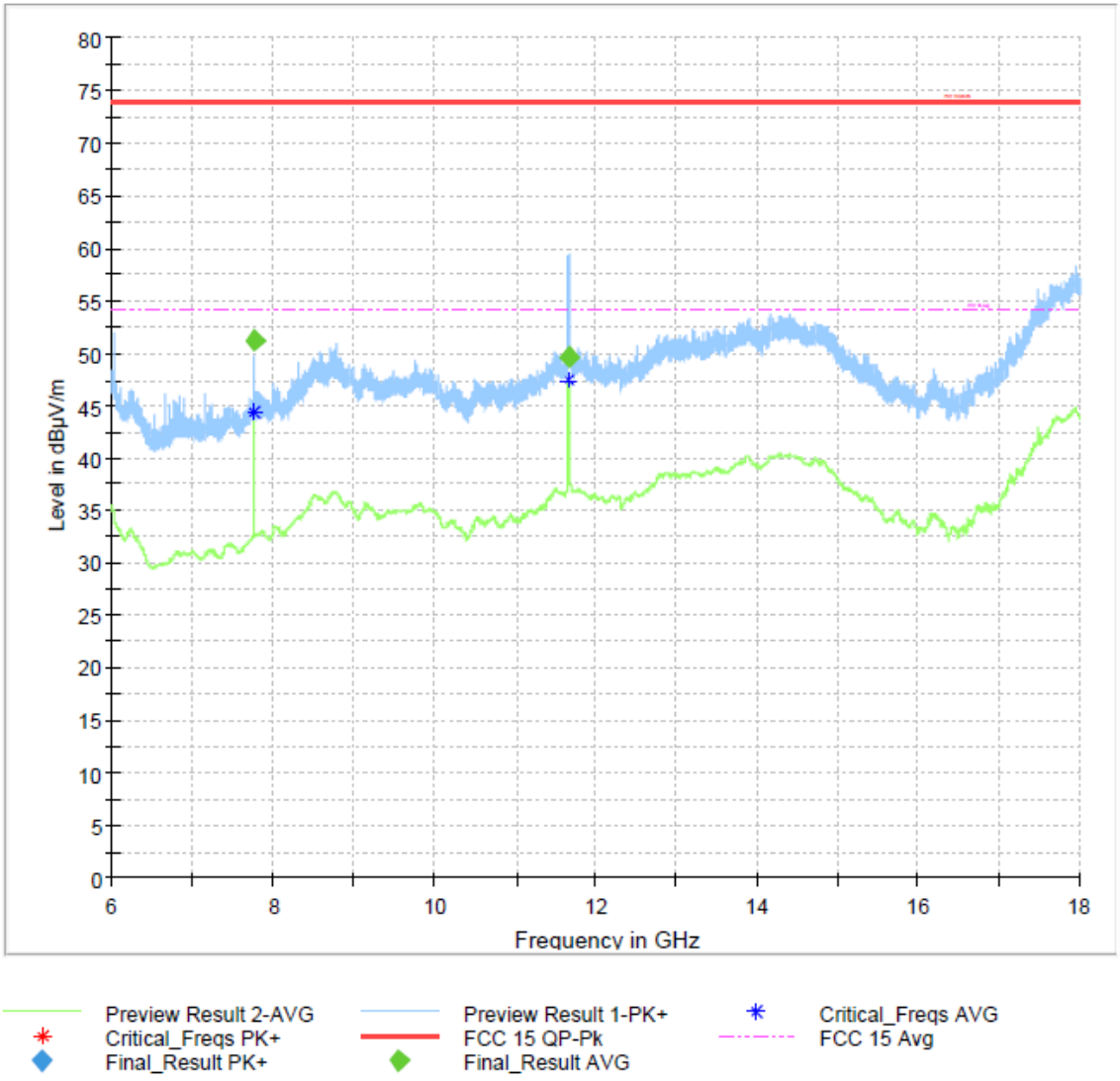


Figure 72: 6-18GHz Channel 165

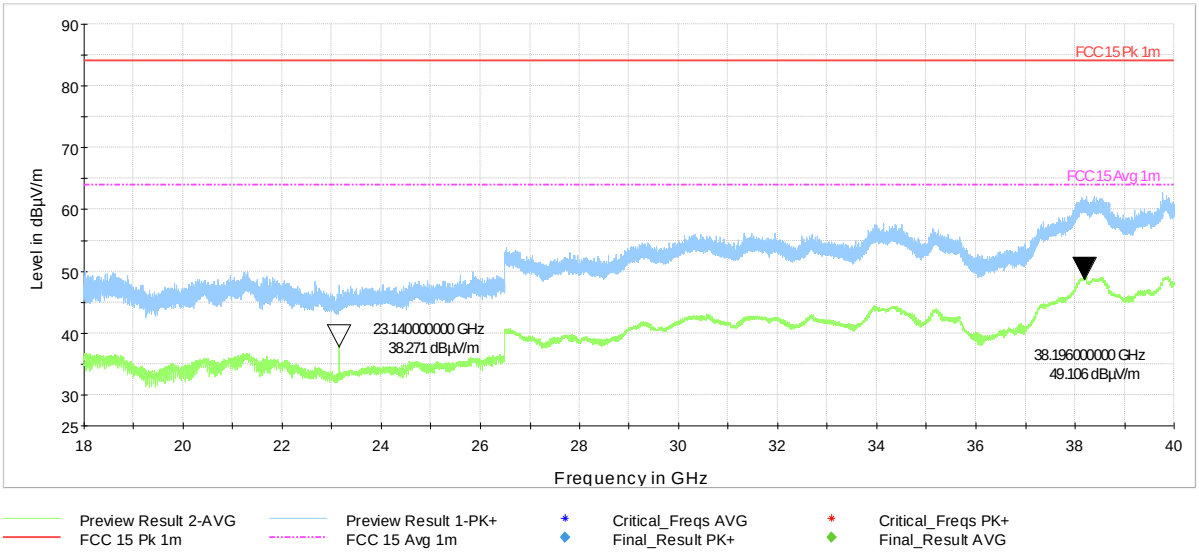


Figure 73: 18-40GHz Channel 157

4.6.4.1.2.2 802.11n HT40 Mode

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
11509.990000	---	48.55	54.00	5.45	500.0	1000.000	159.4	H	45.0	93.9

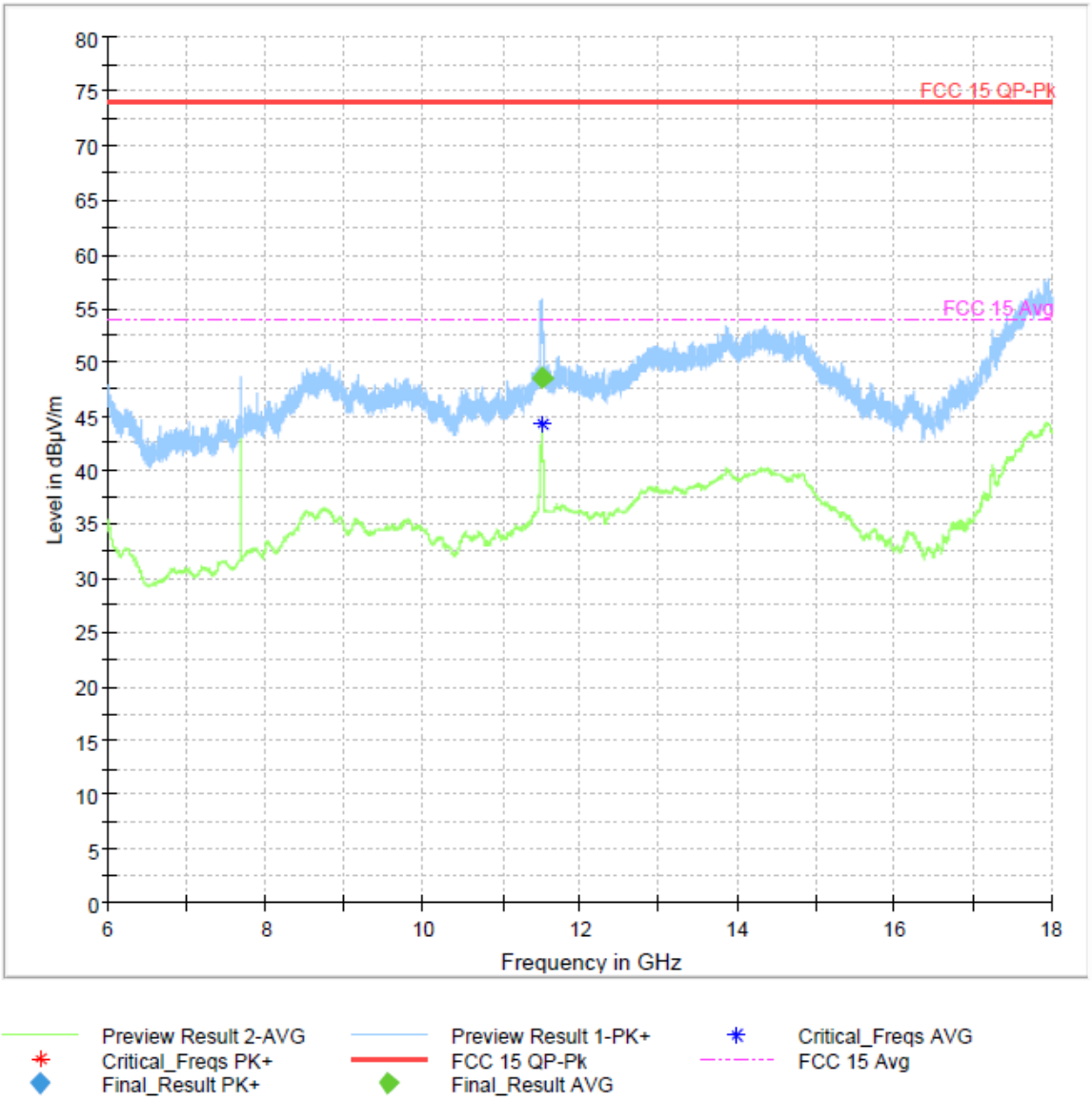


Figure 74: 6-18GHz Channel 151

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
11589.960000	---	48.67	54.00	5.33	500.0	1000.000	184.0	H	100.0	100.0

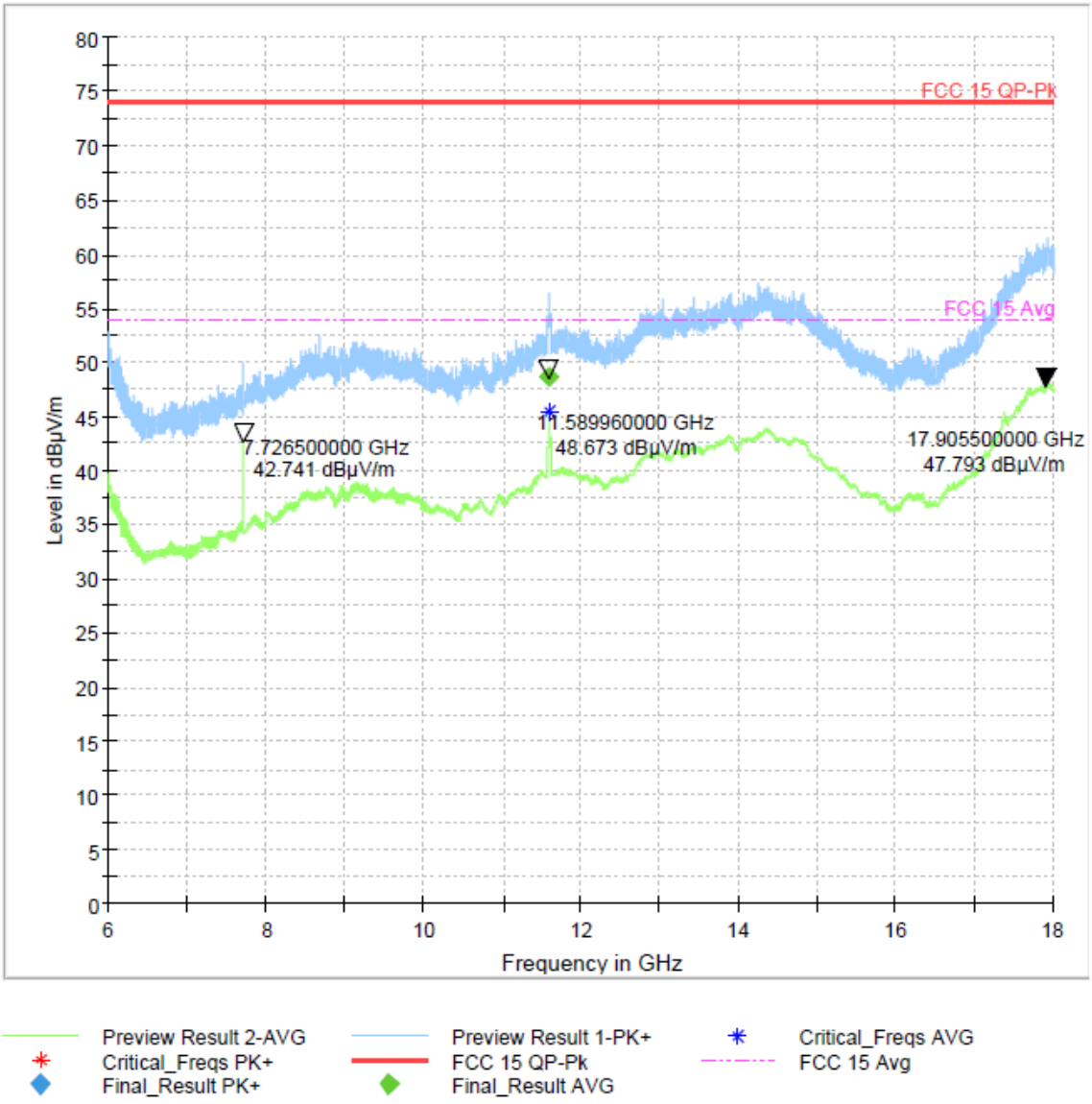


Figure 75: 6-18GHz Channel 159

4.6.4.1.2.3 802.11ac VHT80 Mode

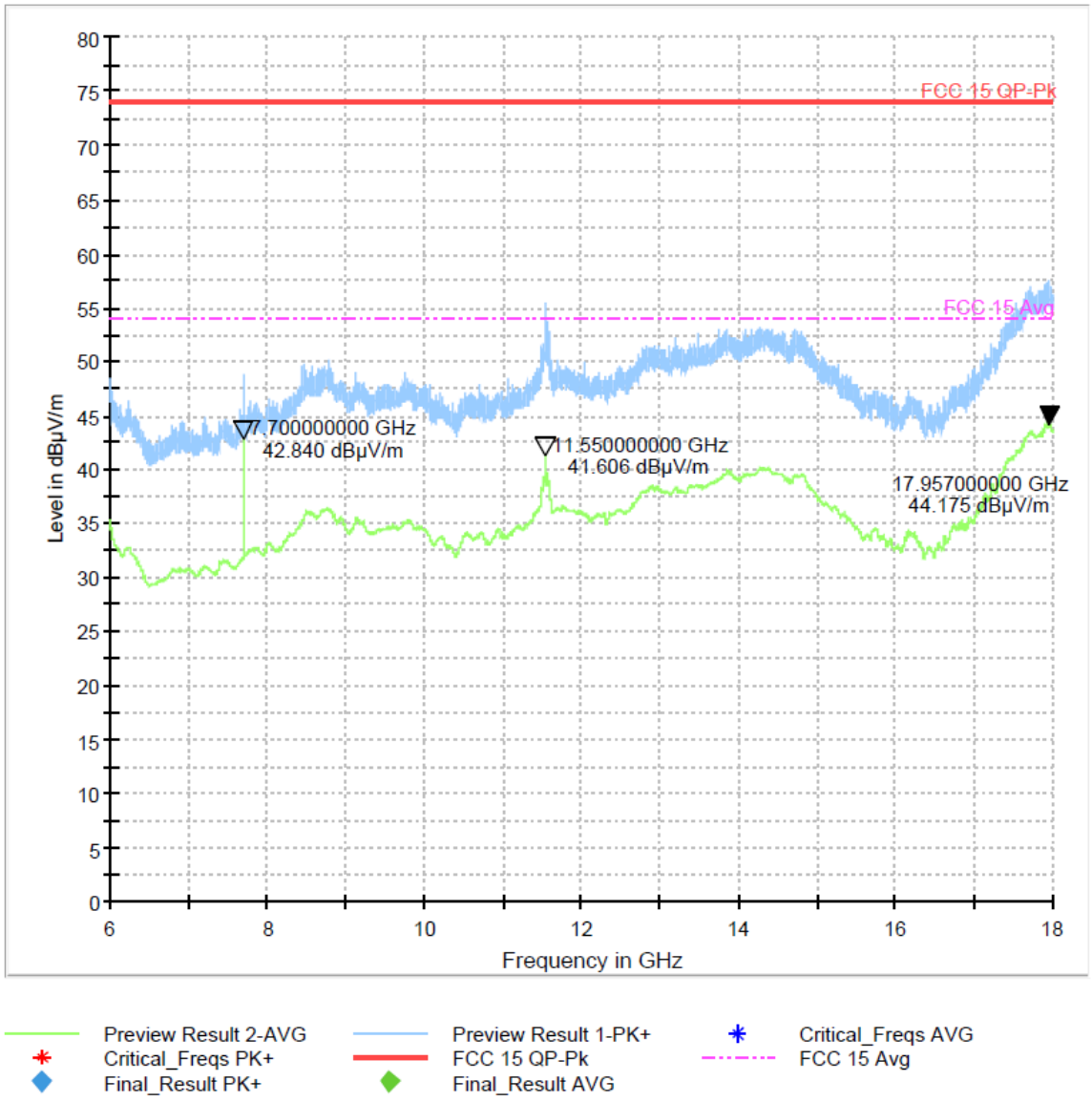


Figure 76: 6-18GHz 802.11ac VHT80 Mode Channel 155

4.7 Frequency Stability

In accordance with 47 CFR Part 15.407(g) and RSS GEN Sect. 6.11 the frequency stability of U-NII devices must be such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

4.7.1 Limit(s)

CFR47 Part 15.407(g) and RSS GEN Sect. 6.11 - Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

4.7.2 Test Methodology

This test is performed according to ANSI C63.10-2013 Section 6.8

4.7.3 Manufacturer Declaration

The EUT conforms to IEEE specs of a maximum +/- 20 PPM for the 5GHz band.

4.7.4 Test results

Pass. The EUT conforms to IEEE specifications of a maximum +/-20 PPM for the 5GHz band under all conditions of normal operation as specified in the user's manual.

5 Test Equipment List

5.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Bilog Antenna	Sunol Sciences	JB3	A102606	08/01/2018	08/01/2020
Horn Antenna	EMCO	3115	9211-3969	05/16/2017	05/16/2019
Active Horn Antenna	Com-Power	AHA-840	105005	05/26/2017	05/26/2019
Active Loop Antenna	EMCO	6502	00062531	05/17/2017	05/17/2019
Spectrum Analyzer	Agilent	N9038A	MY51210195	01/24/2018	01/24/2019
Spectrum Analyzer	Rohde & Schwarz	FSL6	100169	01/13/2018	01/13/2019
Spectrum Analyzer	Rohde & Schwarz	FSW67	104088	6/11/2018	6/11//2019
EMI Receiver	Rohde & Schwarz	ESIB40	832427/002	01/22/2018	01/22/2019
Thermometer	Extech	SD700	Q774118	05/03/2018	05/03/2020
Power Sensors	Rohde & Schwarz	OSP-B157	26160467	01/18/2018	01/18/2019
Vector Signal Generator	Rohde & Schwarz	SMBV100A	257744	9/16/2016	9/16/2019
Base Station Simulator	Rohde & Schwarz	CMW500	103915	12/20/2017	12/20/2018
DC Power Supply	Agilent	E3634A	MY40004331	01/25/2018	01/25/2019
Multimeter	Fluke	177	92780314	01/22/2018	01/22/2019
Amplifier	Sonoma	310N	185516	N/A (See Note)	
Amplifier	Miteq	AMF-7D-01001800-30-10P-L	2074297	N/A (See Note)	
Test Software	Rohde & Schwarz	EMC32 v.10.20.01	N/A	N/A (See Note)	
1.6 GHz Low Pass Filter	K&L Microwave	8L120-X1600-0/09135-0249	UA691-35	N/A (See Note)	
3.5 GHz High Pass Filter	Hewlett Packard	84300-80038	820004	N/A (See Note)	
Band Reject 5150-5888MHz	Micro-Tronics	HPM50107	004	N/A (See Note)	
DC Power Supply	HP	E3634A	3003A-06779	N/A (See Note)	
Signaling Antenna	A.H. Systems, Inc	SAS-571	752	N/A (See Note)	
Signaling Antenna	Commscope	CELLMAX-D-CPUSE	L011504152918	N/A (See Note)	
Maturo Control Unit	Maturo	SCU	246/20571216	N/A	
Maturo EUT Positioner	Maturo	TD1.5-10kg	087/20571216	N/A	

Note: Equipment is characterized before use.

6 EMC Test Plan

6.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

6.2 Customer

Table 9: Customer Information

Company Name	Continental Automotive
Address	21440 West Lake Cook Road
City, State, Zip	Deer Park, Illinois 60010, USA
Country	USA

6.3 Equipment Under Test (EUT)

The information provided in the following table should be listed as it should appear in the final report. For those products that have only a model name, list the model number as *non-applicable* and vice-versa.

Table 10: EUT Designation

Product Name	FB40-ND1
Model Number	FB40-ND1
System Name	NA
Product Description	Embedded communication device for automotive.

6.4 Product Specifications

Table 11: EUT Specifications

EUT Specifications	
Voltage Input	9-16 VDC
Environment	Outdoor (FCC) OEM device installed in Vehicles (ISED)
Operating Temperature Range:	-40° C to 75° C
Multiple Feeds:	☐ Yes and how many ☒ No
Product Marketing Name (PMN)	FB40-ND1
Hardware Version Identification Number (HVIN)	FB40-ND1
Firmware Version Identification Number (FVIN)	4.7.1.3
RF Test Software Version	QRCT QMSL – QLIB V6.1.173,QPST
Operating Modes	802.11a 802.11n (HT20, HT40) 802.11ac (VHT20, VHT40,VHT80)
Transmitter Frequency Band	5.15-5.25 GHz, U-NII-1 Band 5.725-5.85GHz, U-NII-3 Band
Max. Power Output (RMS, Conducted)	11.3 dBm (802.11n HT20)
Power Setting @ Operating Channel	See Section 4.1.4
Antenna Type	See Table 12
Antenna Gain	5150-5250 MHz (U-NII-1): 0.7 dBi 5725-5850 MHz (U-NII-3): 1.9 dBi
Modulation Type	☐ AM ☐ FM ☒ OFDM ☐ Other describe:
TX/RX Chain (s)	1
Directional Gain Type	☐ Correlated (CDD) ☐ Beam-Forming ☒ Other describe:N/A
Type of Equipment	☒ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☐ Other:

Table 12: Antenna Information

Number	Antenna Type	Description	Max Gain (dBi)	
			5150-5250 MHz	5725-5850 MHz
Antenna 0	Internal, PCB type F dual band antenna	5GHz WLAN	0.7	1.9

Table 13: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
N/A	N/A	☐ Yes	☐ Metric: > 3.0m	☐ M

Table 14: Accessory Equipment

Equipment	Manufacturer	Model	Serial	Comment
N/A	N/A	N/A	N/A	N/A
Note: None.				

Table 15: Ancillary Equipment (used for test purposes only)

Equipment	Manufacturer	Model	Serial	Used for
Laptop	HP	Elitebook 8540w	N/A	Stimulating Radios
Note: None.				

Table 16: Description of Sample used for Testing

Sample Number	Device	Serial Number	Configuration	Used For
1	FB40-ND1	U87U050R	Radiated Sample	TX Spurious Emissions
2	FB40-ND1	U87U054G	Conducted Sample	Conducted measurements
Note: -				

Table 17: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup Photo (X-Axis)	Setup Photo (Y-Axis)	Setup Photo (Z-Axis)
FB40-ND1	PCB type F dualband antenna	Transmit	EUT upright	EUT Side	N/A
Note:					

6.5 Test Specifications

Table 18: Test Specifications

Emissions and Immunity	
Standard	**Requirement**
CFR 47 Part 15.407: 2016	All
RSS 247 Issue 2, 2017	All

END OF REPORT