CERTIFICATION TEST REPORT

Report Number. : 12857633-E4V3

Applicant	:	Microsoft Corporation One Microsoft Way Redmond, WA 98052-6399 USA
Model	:	1873
FCC ID	:	C3K1873
IC	:	3048A-1873
EUT Description	:	Portable Computing Device
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART E ISED RSS-247 ISSUE 2 ISED RSS-GEN ISSUE 5

Date Of Issue:
September 24, 2019

Prepared by:
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
FAX: (510) 661-0888

NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	9/3/2019	Initial Issue	---
V2	9/16/2019	Headers fixed Section 5.3: Table Update Section 5.5: Statement added Section 8.5.9, 10, 11, 12: Straddle Updated Section 8.5.14: power updated	Henry Lau
V3	9/24/2019	Section 5.2: Power Updated Section 8.5.14: Power Updated(IC)	Henry Lau

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TABLE OF CONTENTS

REPORT REVISION HISTORY **2**

TABLE OF CONTENTS **3**

1. ATTESTATION OF TEST RESULTS **6**

2. TEST METHODOLOGY **8**

3. FACILITIES AND ACCREDITATION **8**

4. CALIBRATION AND UNCERTAINTY **9**

4.1. MEASURING INSTRUMENT CALIBRATION *9*

4.2. SAMPLE CALCULATION *9*

4.3. MEASUREMENT UNCERTAINTY *9*

5. EQUIPMENT UNDER TEST **10**

5.1. EUT DESCRIPTION *10*

5.2. MAXIMUM OUTPUT POWER *10*

5.3. DESCRIPTION OF AVAILABLE ANTENNAS *12*

5.4. SOFTWARE AND FIRMWARE *12*

5.5. WORST-CASE CONFIGURATION AND MODE *12*

5.6. DESCRIPTION OF TEST SETUP *14*

6. MEASUREMENT METHOD **17**

7. TEST AND MEASUREMENT EQUIPMENT **18**

8. ANTENNA PORT TEST RESULTS **19**

8.1. ON TIME AND DUTY CYCLE *19*

8.2. 26 dB BANDWIDTH *21*

8.2.1. 802.11a MODE IN THE 5.2 GHz BAND 22
8.2.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND 24
8.2.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND 26
8.2.4. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND 27
8.2.5. 802.11a MODE IN THE 5.3 GHz BAND 28
8.2.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND 30
8.2.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND 32
8.2.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND 33
8.2.9. 802.11a MODE IN THE 5.6 GHz BAND 34
8.2.10. 802.11n HT20 MODE IN THE 5.6 GHz BAND 36
8.2.11. 802.11n HT40 MODE IN THE 5.6 GHz BAND 38
8.2.12. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND 40
8.2.13. 802.11a MODE IN THE 5.8 GHz BAND 42

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.14. 802.11n HT20 MODE IN THE 5.8 GHz BAND 44
8.2.15. 802.11n HT40 MODE IN THE 5.8 GHz BAND 46
8.2.16. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND 47

8.3. 99% BANDWIDTH 48
8.3.1. 802.11a MODE IN THE 5.2 GHz BAND 49
8.3.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND 51
8.3.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND 53
8.3.4. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND 54
8.3.5. 802.11a MODE IN THE 5.3 GHz BAND 55
8.3.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND 57
8.3.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND 59
8.3.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND 60
8.3.9. 802.11a MODE IN THE 5.6 GHz BAND 61
8.3.10. 802.11n HT20 MODE IN THE 5.6 GHz BAND 65
8.3.11. 802.11n HT40 MODE IN THE 5.6 GHz BAND 69
8.3.12. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND 71
8.3.13. 802.11a MODE IN THE 5.8 GHz BAND 73
8.3.14. 802.11n HT20 MODE IN THE 5.8 GHz BAND 75
8.3.15. 802.11n HT40 MODE IN THE 5.8 GHz BAND 77
8.3.16. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND 78

8.4. 6 dB BANDWIDTH 79
8.4.1. 802.11a MODE IN THE 5.8 GHz BAND 80
8.4.2. 802.11n HT20 MODE IN THE 5.8 GHz BAND 82
8.4.3. 802.11n HT40 MODE IN THE 5.8 GHz BAND 84
8.4.4. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND 86

8.5. OUTPUT POWER AND PSD 87
8.5.1. 802.11a MODE IN THE 5.2 GHz BAND 91
8.5.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND 97
8.5.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND 103
8.5.4. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND 107
8.5.5. 802.11a MODE IN THE 5.3 GHz BAND 109
8.5.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND 115
8.5.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND 121
8.5.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND 125
8.5.9. 802.11a MODE IN THE 5.6 GHz BAND 127
8.5.10. 802.11n HT20 MODE IN THE 5.6 GHz BAND 133
8.5.11. 802.11n HT40 MODE IN THE 5.6 GHz BAND 139
8.5.12. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND 145
8.5.13. 802.11a MODE IN THE 5.8 GHz BAND 151
8.5.14. 802.11n HT20 MODE IN THE 5.8 GHz BAND 157
8.5.15. 802.11n HT40 MODE IN THE 5.8 GHz BAND 163
8.5.16. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND 167

9. RADIATED TEST RESULTS 169

9.1. TRANSMITTER ABOVE 1 GHz 171
9.1.1. TX ABOVE 1 GHz 802.11a MODE IN THE 5.2 GHz BAND 171
9.1.2. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND 179
9.1.3. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND 187
9.1.4. TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.2 GHz BAND 193
9.1.5. TX ABOVE 1 GHz 802.11a MODE IN THE 5.3 GHz BAND 197

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.1.6. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.3 GHz BAND.....205
9.1.7. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.3 GHz BAND.....213
9.1.8. TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.3 GHz BAND.....219
9.1.9. TX ABOVE 1 GHz 802.11a MODE IN THE 5.6 GHz BAND 223
9.1.10. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.6 GHz BAND.....235
9.1.11. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.6 GHz BAND.....247
9.1.12. TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.6 GHz BAND.....259
9.1.13. TX ABOVE 1 GHz 802.11a MODE IN THE 5.8 GHz BAND 269
9.1.14. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.8 GHz BAND.....279
9.1.15. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.8 GHz BAND.....289
9.1.16. TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.8 GHz BAND.....297

9.2. SPURIOUS EMISSIONS FOR COLLOCATION.....303

9.3. WORST CASE BELOW 30MHZ 304

9.4. WORST CASE BELOW 1 GHZ.....305

9.5. WORST CASE 18-26 GHZ 307

9.6. WORST CASE 26-40 GHZ 309

10. AC POWER LINE CONDUCTED EMISSIONS 311

10.1.1. AC Power Line Norm 312

11. SETUP PHOTOS.....314

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
USA

EUT DESCRIPTION: Portable Computing Device

MODEL: 1873

SERIAL NUMBER: 009075792757 (Conducted)
009060692757 (Radiated)
009059592757 (Radiated)

DATE TESTED: July 30, 2019 – August 20, 2019

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart E	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

Approved & Released For
UL Verification Services Inc. By:

FRANCISCO DE ANDA
OPERATIONS LEADER
Consumer Technology Division
UL Verification Services Inc.

Prepared By:

ERIC YU
TEST ENGINEER
Consumer Technology Division
UL Verification Services Inc.

Reviewed By:

HENRY LAU
PROJECT ENGINEER
Consumer Technology Division
UL Verification Services Inc.

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 14-30, FCC KDB 662911 D01 v02r01, FCC KDB 905462 D02 v02/D03 v01r02/D06 v02, FCC KDB 789033 D02 v02r01, FCC KDB 644545 D03 v01, ANSI C63.10-2013, FCC 06-96, RSS-GEN Issue 5, and RSS-247 Issue 2.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Road
☐ Chamber A	☐ Chamber D	☒ Chamber I
☐ Chamber B	☐ Chamber E	☒ Chamber J
☐ Chamber C	☐ Chamber F	☒ Chamber K
	☐ Chamber G	☐ Chamber L
	☐ Chamber H	☐ Chamber M

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

RADIATED EMISSIONS
Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

MAINS CONDUCTED EMISSIONS
Where relevant, the following sample calculation is provided:
Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.
36.5 dBuV + 0 dB +10.1 dB+ 0 dB = 46.6 dBuV

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.52 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	4.88 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.24 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.37 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.17 dB

Uncertainty figures are valid to a confidence level of 95%.

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The EUT is a portable computing device.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

5.2 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.2 GHz band, 2TX			
5180-5240	802.11a Legacy	10.16	10.38
5180-5240	802.11n HT20	10.25	10.59
5190-5230	802.11n HT40	13.57	22.75
5210	802.11ac VHT80	14.28	26.79

5.3 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.3 GHz band, 2TX			
5260 - 5320	802.11a Legacy	16.38	43.45
5260 - 5320	802.11n HT20	16.61	45.81
5270 - 5310	802.11n HT40	19.33	85.70
5290	802.11ac VHT80	17.24	52.97

5.6 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.6 GHz band, 2TX			
5500-5720	802.11a Legacy	16.05	40.27
5500-5720	802.11n HT20	16.40	43.65
5510-5710	802.11n HT40	19.54	89.95
5530-5690	802.11ac VHT80	19.83	96.16

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.8 GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.8 GHz band, 2TX			
5745-5825	802.11a Legacy	19.17	82.60
5745-5825	802.11n HT20	19.41	87.30
5755-5795	802.11n HT40	19.06	80.54
5775	802.11ac VHT80	19.42	87.50

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Radio utilizes two dual band PIFA antennas, with a maximum gain of dBi:

Frequency (GHz)	Peak Antenna Gain (dBi)	
	Chain 0	Chain 1
5150-5250	7.5	2.4
5250-5350	8.4	2.9
5470-5725	7.9	4.9
5725-5850	7.9	3.5

Note:
Antenna 1 = Chain 0
Antenna 2 = Chain 1

5.4. SOFTWARE AND FIRMWARE

The operating system installed on the EUT is Windows 10 Pro build 18362.19h1_release.190318-1202.

The Driver installed on the EUT is version 12.0.0.835.

The test utility software used during testing was QRCT v4.0.00125

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 30MHz, 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

For all modes, tests were performed with the EUT set at the 2Tx CDD mode with power setting equal to SISO modes as the worst case scenario thus MIMO is representative of SISO.

802.11ac VHT20 and VHT40 mode have the same power settings as 802.11n HT20 and HT40, thus 802.11n HT20 and HT40 are representative of VHT20 and VHT40.

The EUT has one intended orientations, X; therefore, all final radiated testing was performed with the EUT in X orientation.

Worst-case data rates as provided by the client were:

802.11a mode: 6 Mbps
802.11n HT20mode: MCS0
802.11n HT40mode: MCS0

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

802.11ac VHT80 mode: MCS0

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC DC Adapter	Microsoft	1706	0CI30J0IZ9396	DoC
AC DC Adapter	Lenovo	ADLX45NDC2A	11S45N0291Z1ZS925 3E2N9	DoC
Laptop	Lenovo	E555	6449237	TX2-RTL8723BE
Mouse	Logitech	B100	1451HS05PX68	DoC
USB 3.0 Gigabit Ethernet Adapter	Linksys	1113	X821908-002	DoC
USB Type C to Audio Jack	SONY	A1-0231	N/A	DoC

I/O CABLES (CONDUCTED TEST)

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-Shielded	1	to AC/DC Adaptor
2	DC	1	DC	Shielded	1.2	to Laptop, to EUT
3	Antenna	1	SMA	Un-Shielded	0.2	to Analyzer
4	USB	1	TYPE A	Shielded	0.2	USB-A to RJ45 converter
5	Ethernet	1	RJ45	Un-Shielded	0.5	Support Laptop to Ethernet Adapter
6	AC	1	AC	Un-Shielded	1	to AC/DC Adaptor
7	DC	1	DC	Shielded	1.2	to Support Equipment

I/O CABLES (RADIATED AND CONDUCTED EMISSIONS)

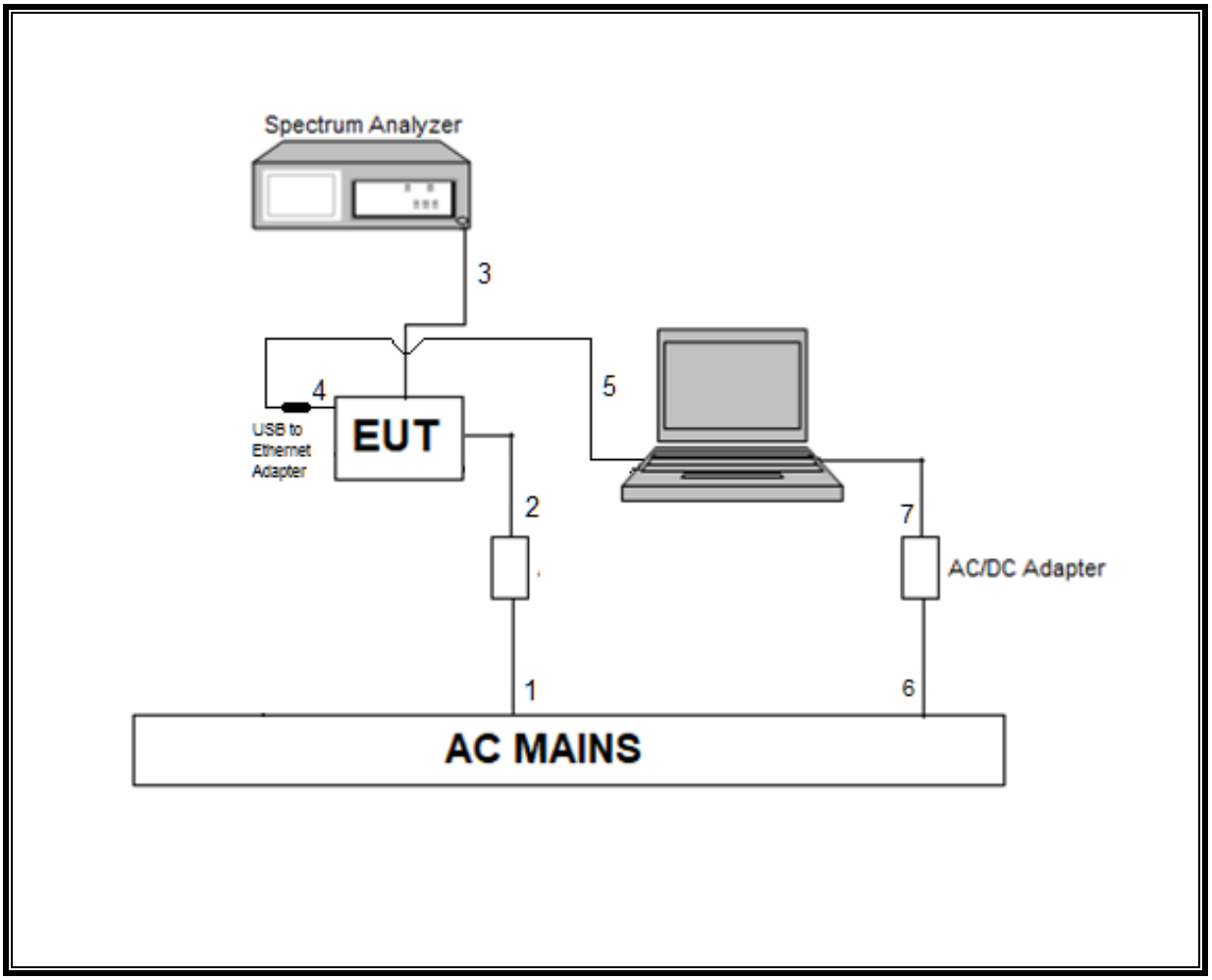
I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	1	to AC/DC Adapter
2	DC	1	DC	Shielded	1.2	to EUT
3	USB	1	TYPE A	Shielded	1.5	EUT to Mouse
4	USB	1	Type C	Shielded	0.1	USB-C to Audio Jack converter
5	Earphone	2	3.5mm	Un-shielded	1	EUT to earphone

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

CONDUCTED TEST SETUP DIAGRAM

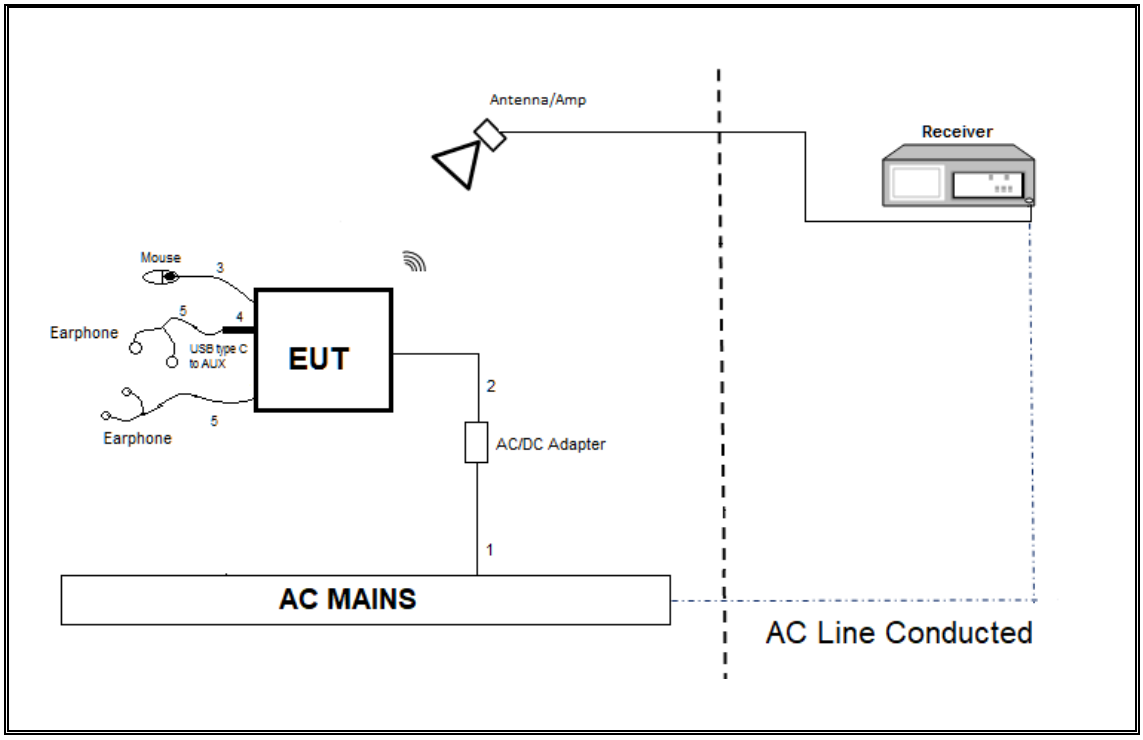


TEST SETUP

For conducted tests, the EUT was connected to a laptop. The test software exercises the radio.

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RADIATED AND AC LINE CONDUCTED EMISSIONS SETUP DIAGRAM



TEST SETUP

For radiated tests and AC line conducted tests: EUT is connected to all support equipment. The test software exercises the radio. Support laptop was removed after EUT was configured.

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

6. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 789033 D02 v02r01, Section B.

6 dB Emission BW: KDB 789033 D02 v02r01, Section C.2

26 dB Emission BW: KDB 789033 D02 v02r01, Section C.1

99% Occupied BW: KDB 789033 D02 v02r01, Section D.

Conducted Output Power: KDB 789033 D02 v02r01, Section E.3.b (Method PM-G) and KDB 789033 D02 v02r01, Section E.2.b (Method SA-1)

Power Spectral Density: KDB 789033 D02 v02r01, Section F

Unwanted emissions in restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, and G.5.

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

7. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST					
Description	**Manufacturer**	**Model**	**ID Num**	**Cal Due**	**Last Cal**
Antenna, Passive Loop 30Hz to 1MHz	ELETRO METRICS	EM-6871	PRE0179465	05/31/2020	05/31/2019
Antenna, Passive Loop 100kHz to 30MHz	ELETRO METRICS	EM-6872	PRE0179467	05/31/2020	05/31/2019
Amplifier, 9kHz to 1GHz, 32 dB	Sonoma Instrument	310	PRE0180175	06/29/2020	06/29/2019
Antenna, Broadband Hybrid, 30MHz to 3GHz	Sunol Sciences Corp.	JB3	PRE0184971	11/13/2019	11/13/2018
Amplifier, 9kHz to 1GHz, 32 dB	Sonoma Instrument	310	PRE0180174	06/01/2020	06/01/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	EMC4294	06/14/2020	06/14/2019
Amplifier, 1 to18GHz	AMPLICAL	AMP1G18-35	T1569	06/04/2020	06/04/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T862	06/05/2020	06/05/2019
Amplifier, 1 to18GHz	MITEQ	AFS42-00101800-25-S-42	PRE0181078	08/31/2019	08/01/2018
Amplifier, 1 to18GHz	MITEQ	AFS42-00101800-25-S-42	PRE0181078	08/24/2020	08/24/2019
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	PRE0182188	08/29/2019	08/29/2018
Rf Amplifier, 18-26.5GHz, 60dB gain	Amplical	AMP18G26.5-60	PRE0181238	05/01/2020	05/01/2019
Antenna, Horn 26 to 40GHz	ARA	MWH-2640	T90	09/11/2019	09/11/2018
Pre-Amp, 26-40GHz	Amplical	AMP26G40-60	PRE0181239	05/01/2020	05/01/2019
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T1265	01/29/2020	01/29/2019
Power Sensor, P-series, 50MHz to 18GHz, Wideband	Agilent (Keysight) Technologies	N1921A	T1227	02/05/2020	02/05/2019
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0179367	05/16/2020	05/16/2019
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0179372	02/16/2020	02/16/2019
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0179367	05/16/2020	05/16/2019
EMI Test Receiver	Rohde & Schwarz	ESW44	PRE0179376	02/14/2020	02/14/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T917	01/24/2020	01/24/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T908	01/23/2020	01/23/2019
AC Line Conducted					
EMI Receiver	Rohde & Schwarz	ESR	T1436	02/14/2020	02/14/2019
LISN for Conducted Emissions CISPR-16	FCC INC.	FCC LISN 50/250	T1310	01/24/2020	01/24/2019
Test Software List					
Radiated Software	UL	UL EMC		Ver 9.5, June 15, 2019	
Antenna Port Software	UL	UL RF		Ver 10.0.1, July 23, 2019	
AC Line Conducted Software	UL	UL EMC		Ver 9.5, May 26, 2015	

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

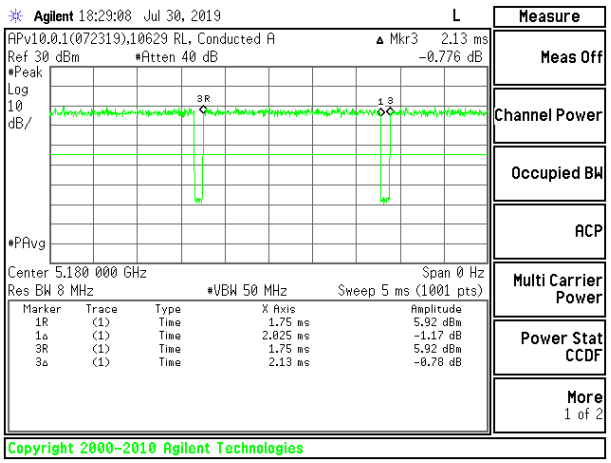
KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

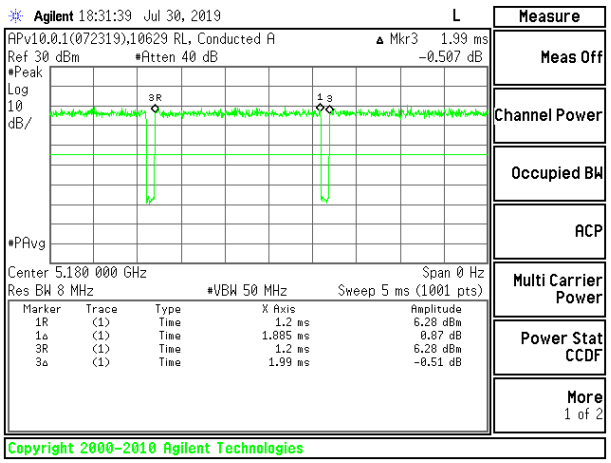
Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
802.11a	2.025	2.130	0.951	95.07%	0.22	0.494
802.11n HT20	1.885	1.990	0.947	94.72%	0.24	0.531
802.11n HT40	0.927	1.026	0.904	90.37%	0.44	1.079
802.11ac VHT80	0.4547	0.550	0.827	82.72%	0.82	2.199

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

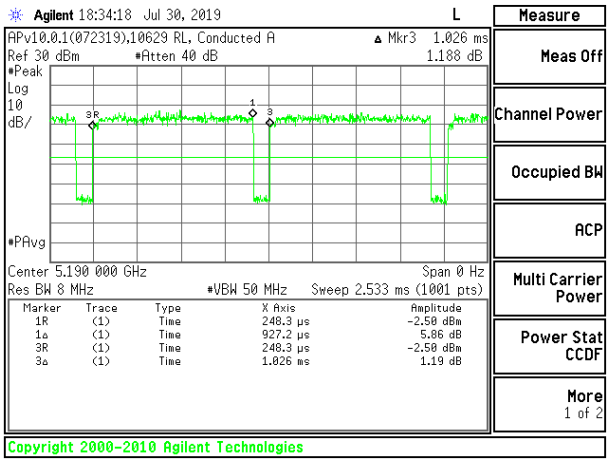
DUTY CYCLE PLOTS



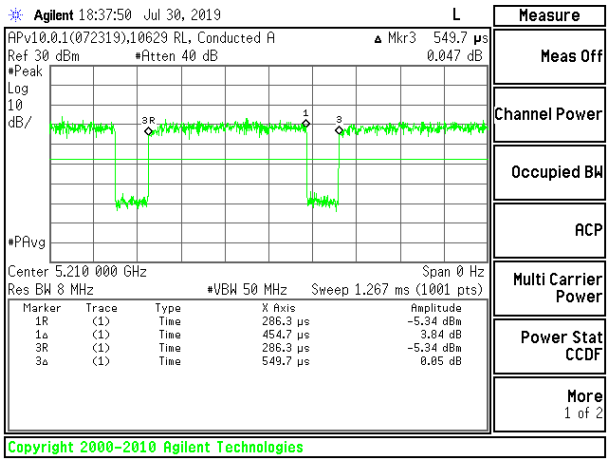
DUTY CYCLE 802.11a MODE



DUTY CYCLE 802.11n HT20 MODE



DUTY CYCLE 802.11n HT40 MODE



DUTY CYCLE 802.11ac VHT80 MODE

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

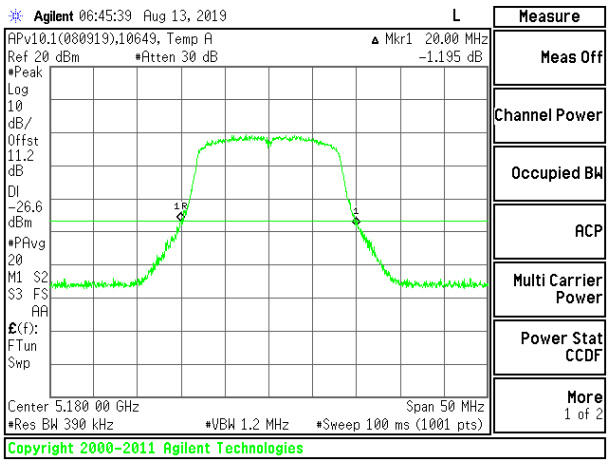
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.1. 802.11a MODE IN THE 5.2 GHz BAND

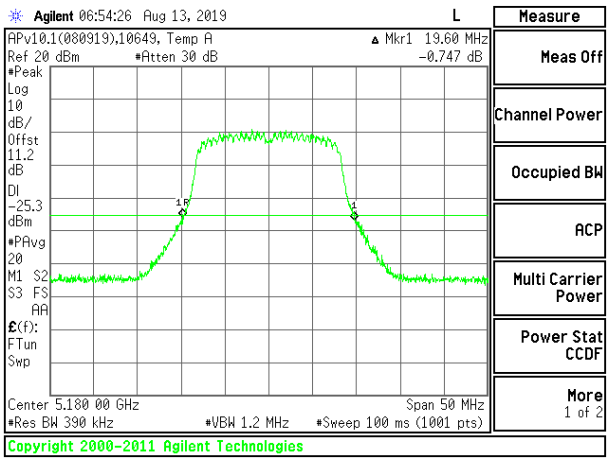
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5180	20.00	19.60
Mid	5200	19.75	19.45
High	5240	19.50	20.05

LOW CHANNEL

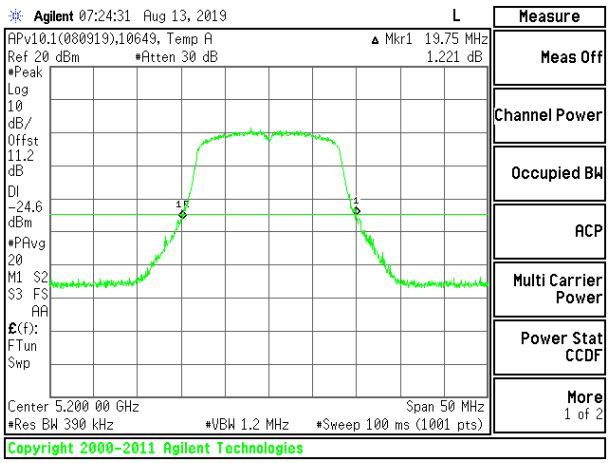


LOW CHANNEL CHAIN 0

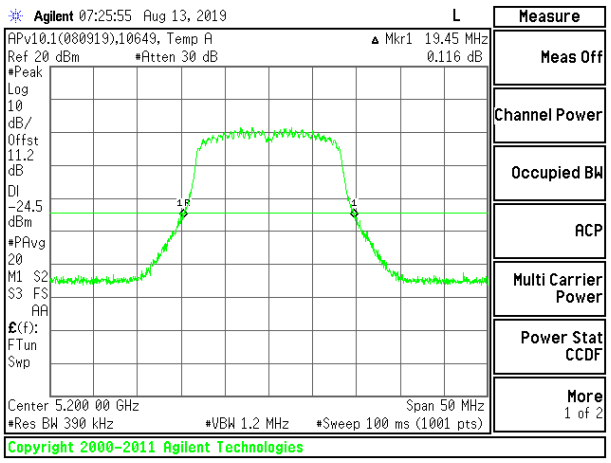


LOW CHANNEL CHAIN 1

MID CHANNEL



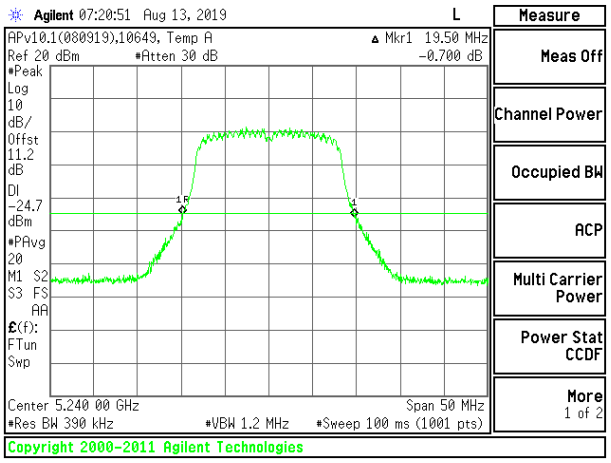
MID CHANNEL CHAIN 0



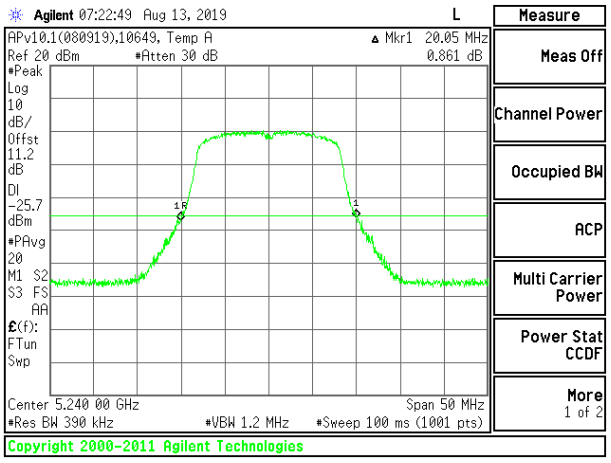
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

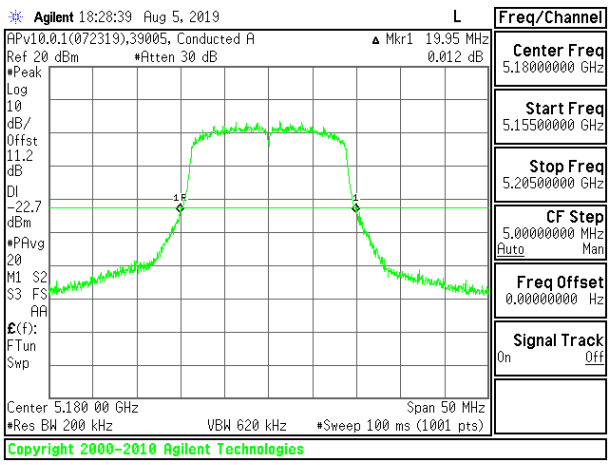
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

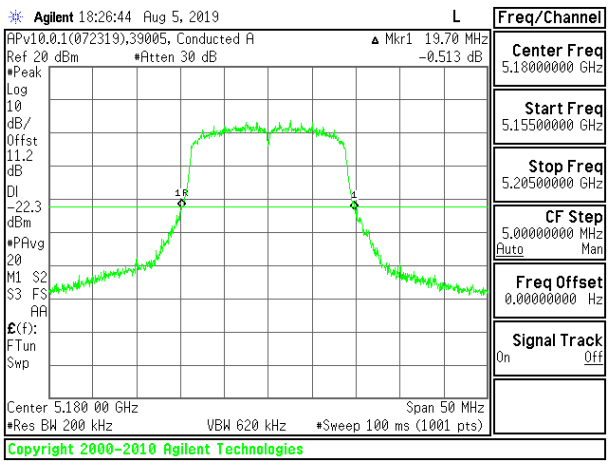
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5180	19.95	19.70
Mid	5200	19.80	19.90
High	5240	19.80	19.80

LOW CHANNEL

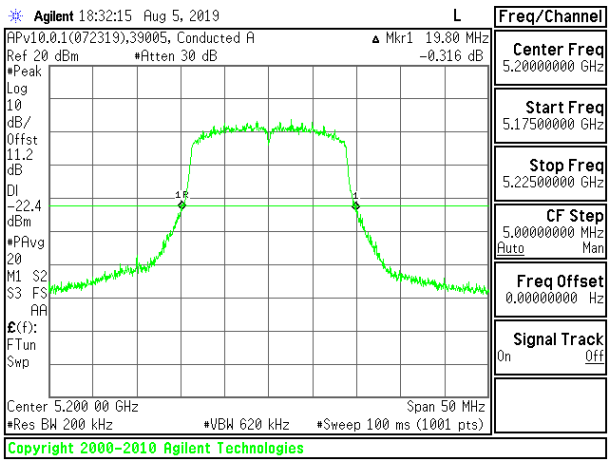


LOW CHANNEL CHAIN 0

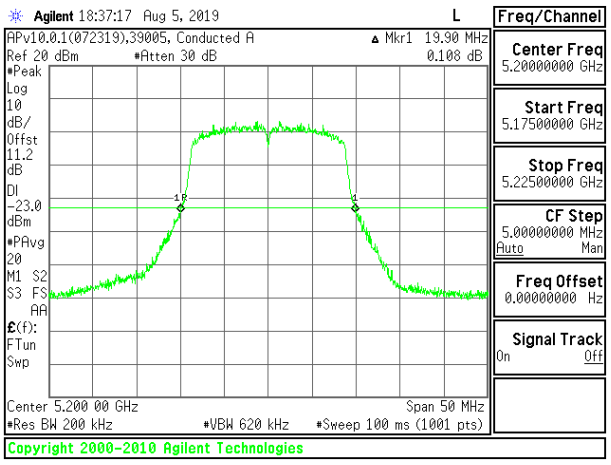


LOW CHANNEL CHAIN 1

MID CHANNEL



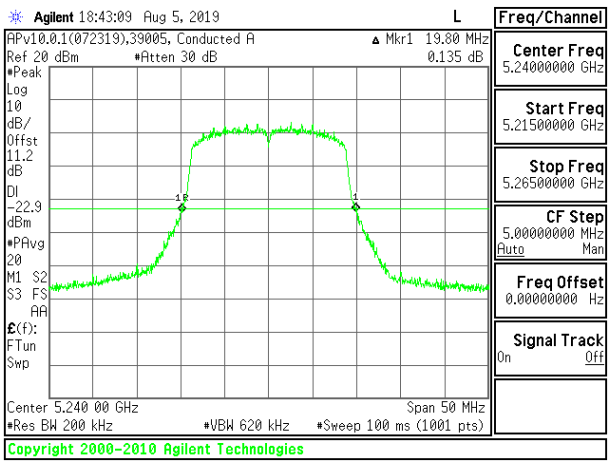
MID CHANNEL CHAIN 0



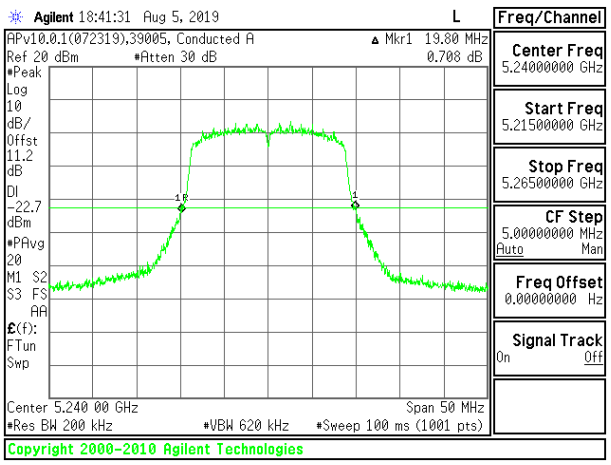
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

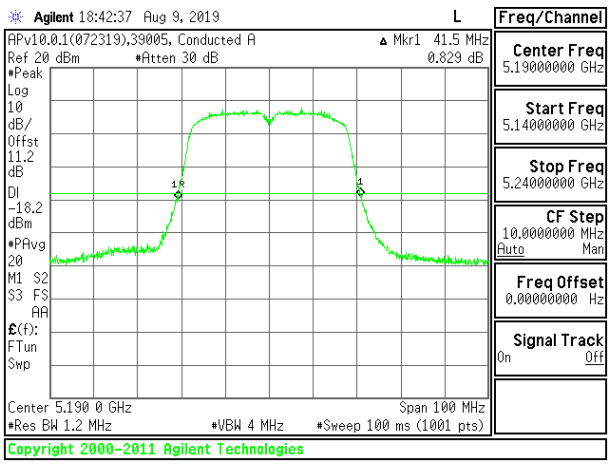
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND

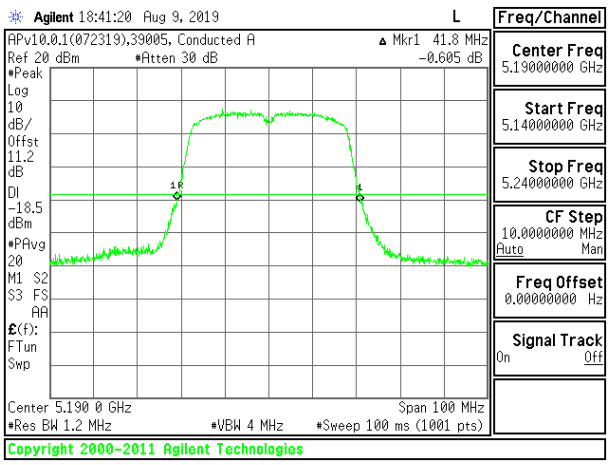
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5190	41.50	41.80
High	5230	41.80	41.70

LOW CHANNEL

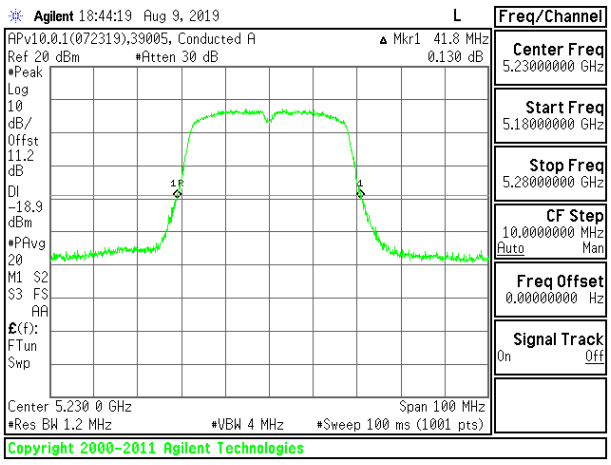


LOW CHANNEL CHAIN 0

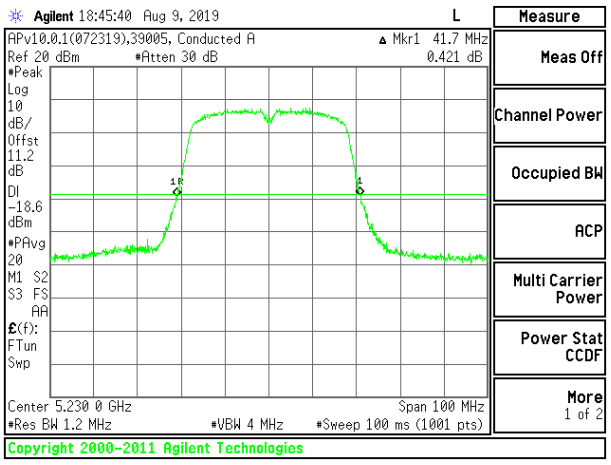


LOW CHANNEL CHAIN 1

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

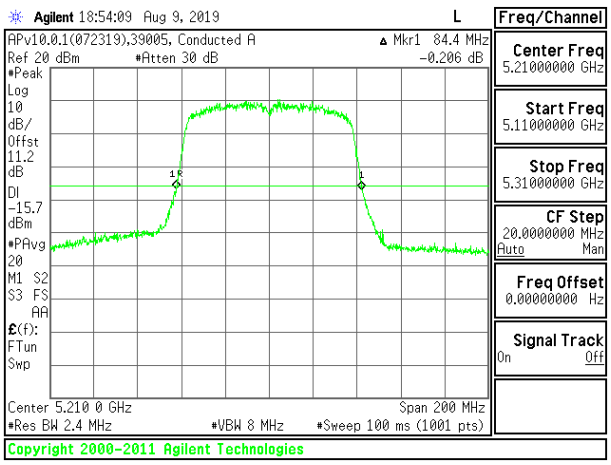
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.4. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND

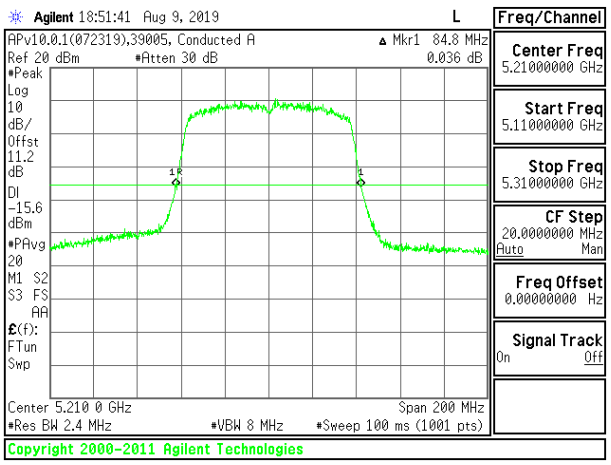
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Mid	5210	84.40	84.80

MID CHANNEL



MID CHANNEL CHAIN 0



MID CHANNEL CHAIN 1

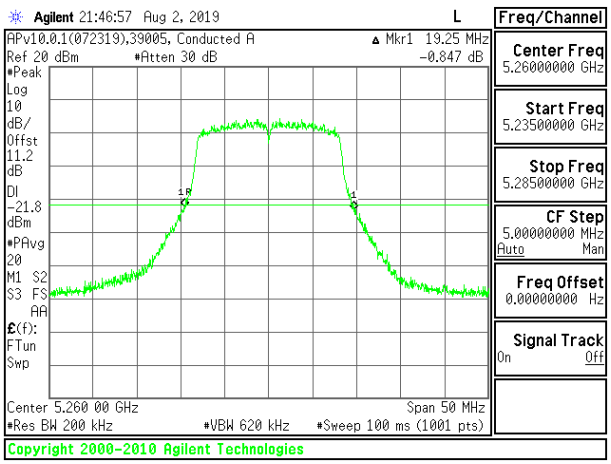
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.5. 802.11a MODE IN THE 5.3 GHz BAND

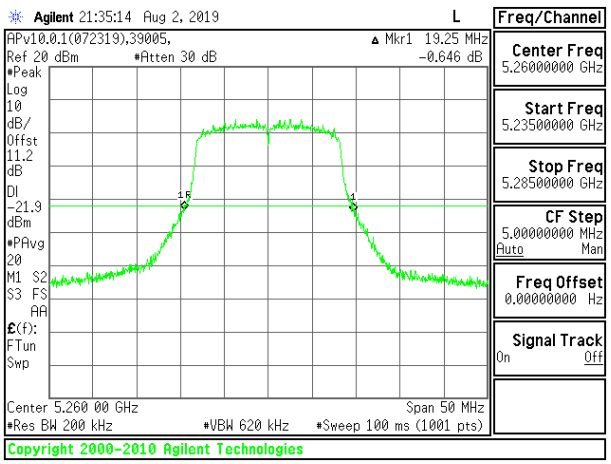
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5260	19.25	19.25
Mid	5300	19.55	19.35
High	5320	19.20	19.30

LOW CHANNEL

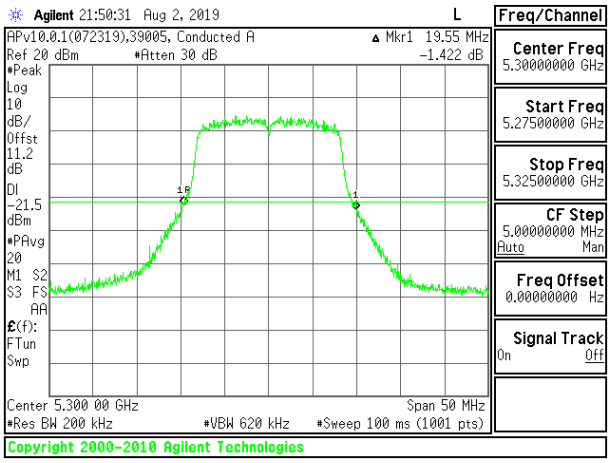


LOW CHANNEL CHAIN 0

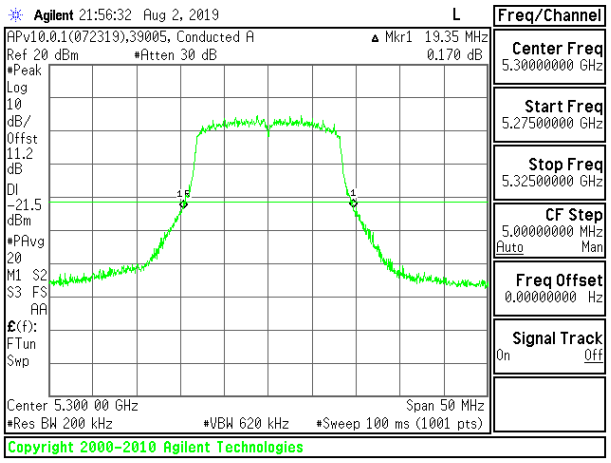


LOW CHANNEL CHAIN 1

MID CHANNEL



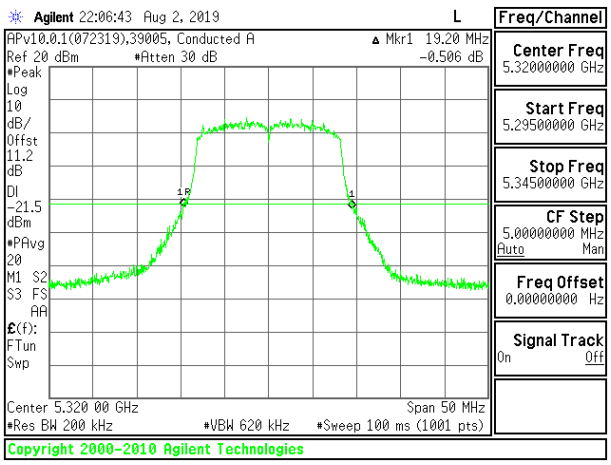
MID CHANNEL CHAIN 0



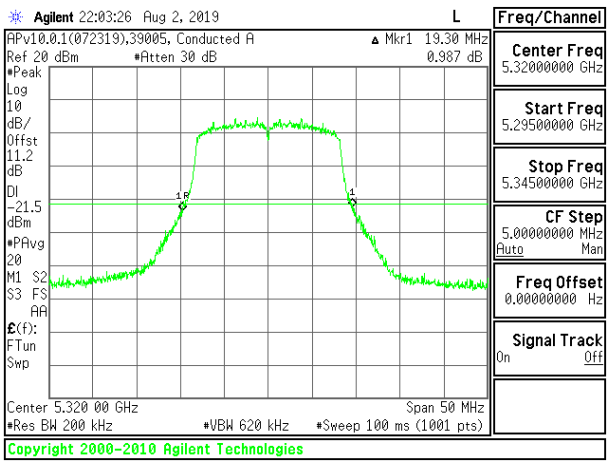
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

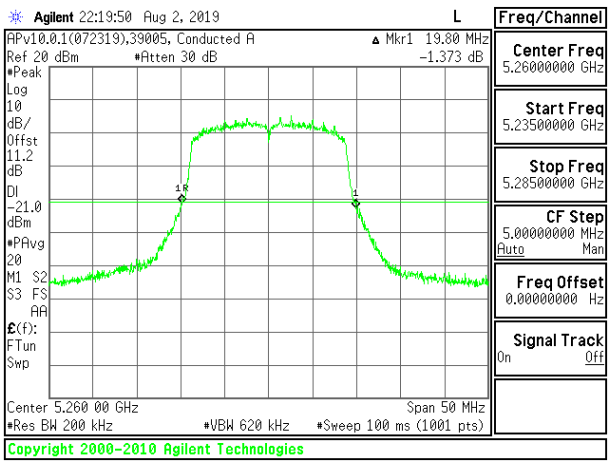
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND

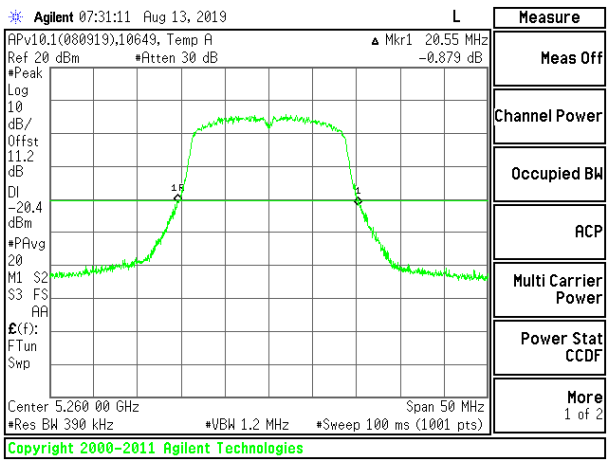
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5260	19.80	20.55
Mid	5300	19.70	19.75
High	5320	19.85	20.00

LOW CHANNEL

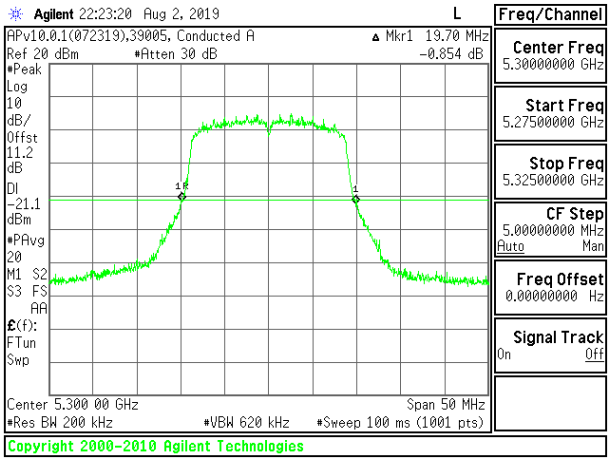


LOW CHANNEL CHAIN 0

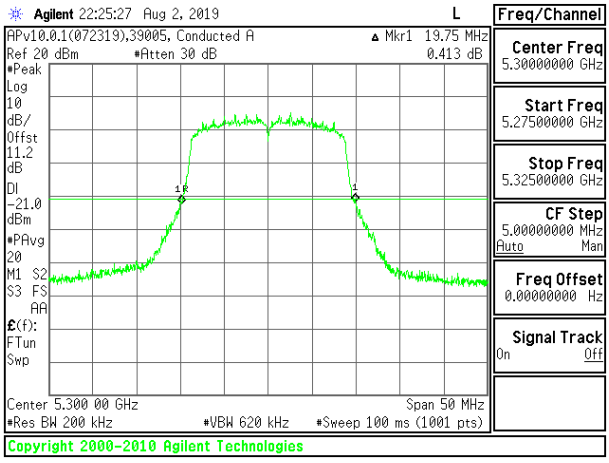


LOW CHANNEL CHAIN 1

MID CHANNEL



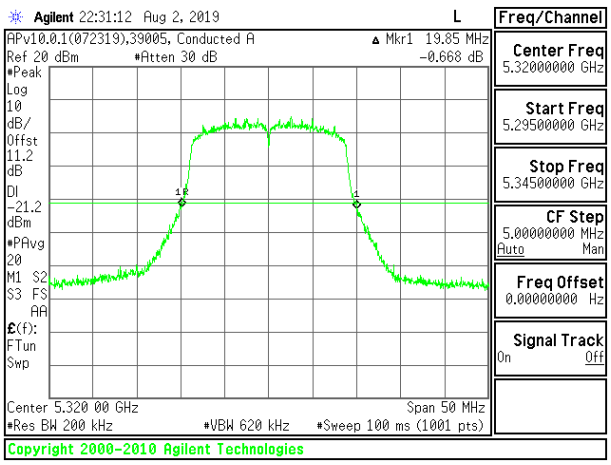
MID CHANNEL CHAIN 0



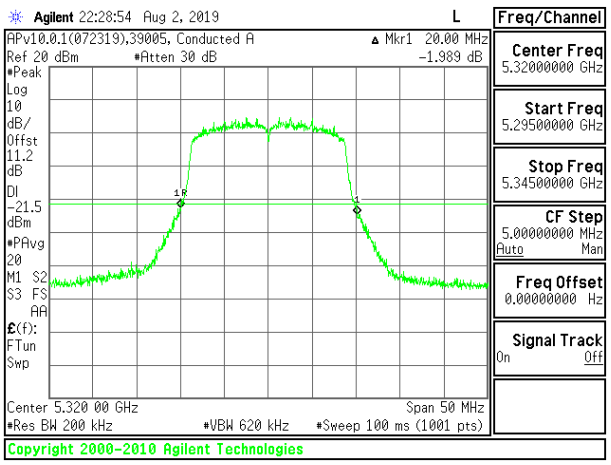
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

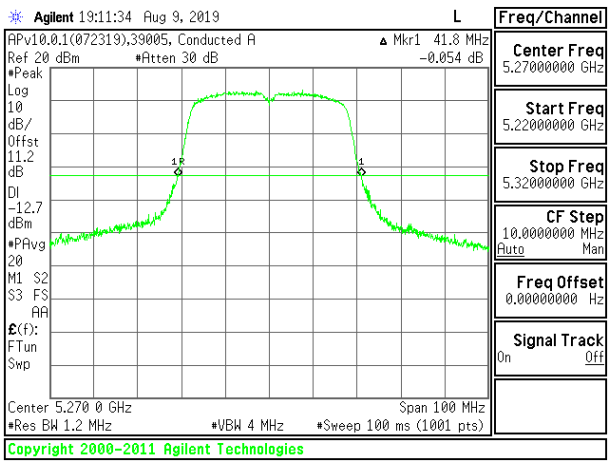
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND

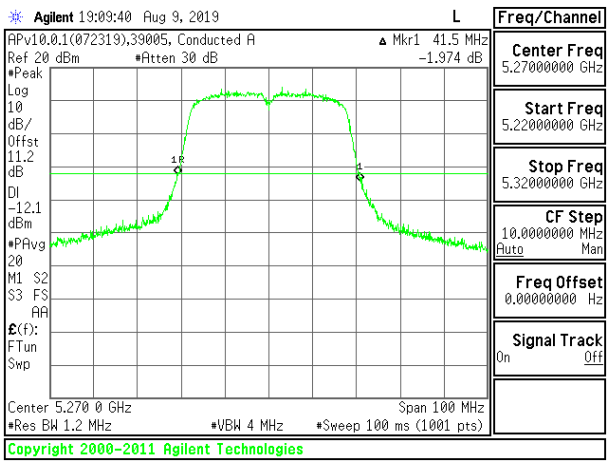
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5270	41.80	41.50
High	5310	41.70	41.60

LOW CHANNEL

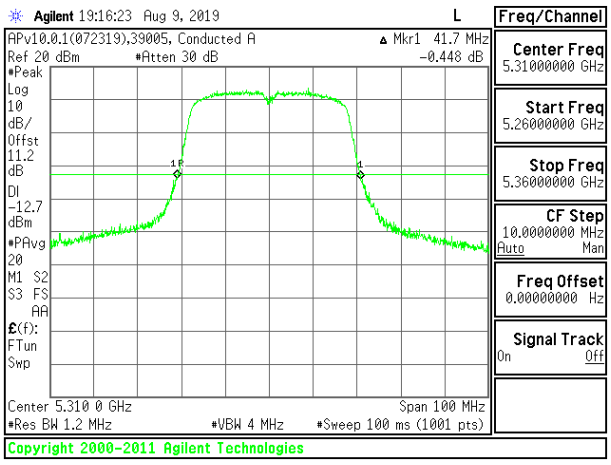


LOW CHANNEL CHAIN 0

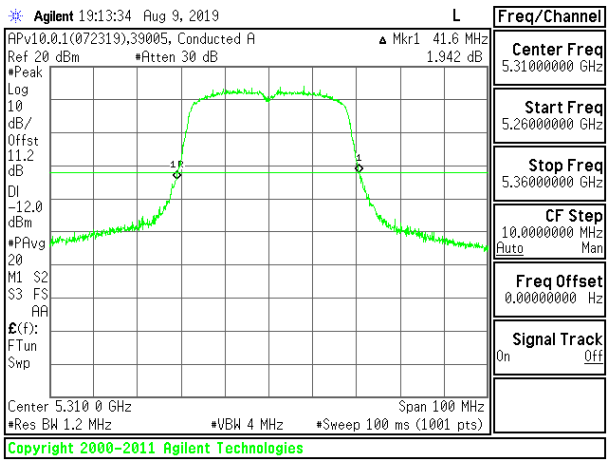


LOW CHANNEL CHAIN 1

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

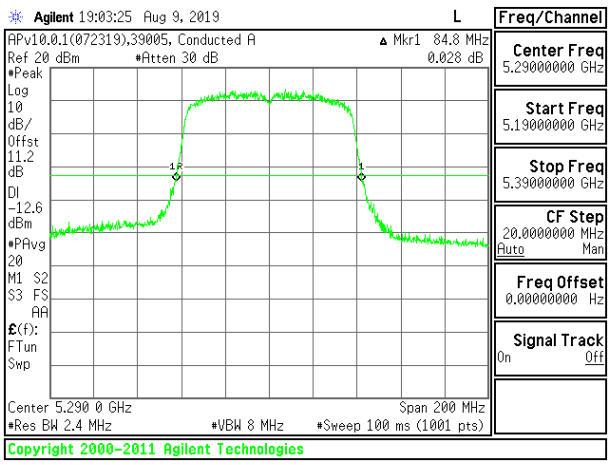
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND

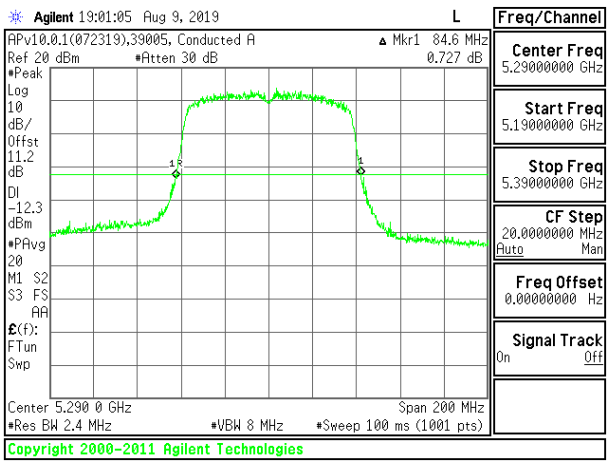
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Mid	5290	84.80	84.60

MID CHANNEL



MID CHANNEL CHAIN 0



MID CHANNEL CHAIN 1

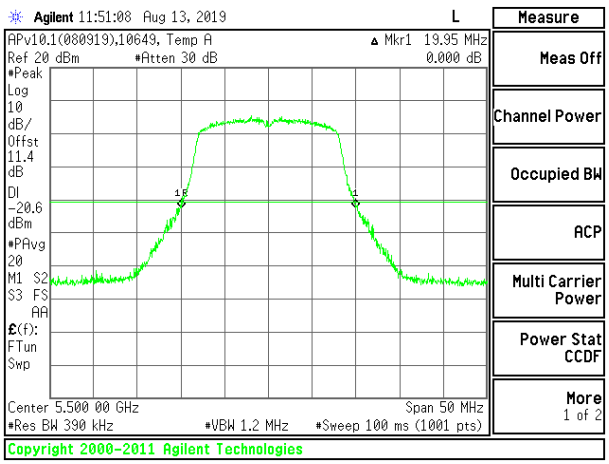
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.9. 802.11a MODE IN THE 5.6 GHz BAND

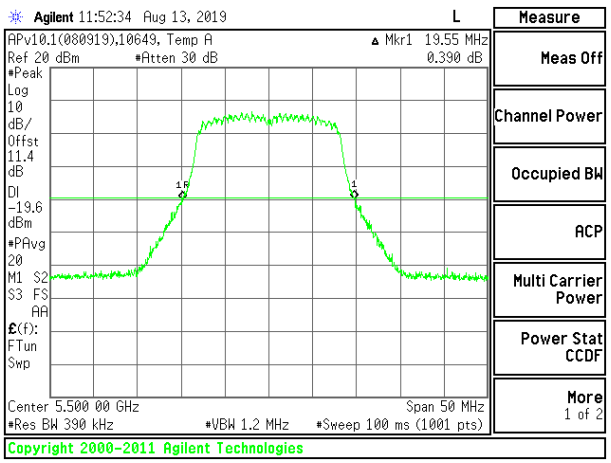
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5500	19.55	19.55
Mid	5580	20.00	19.65
High	5700	19.85	19.60
144	5720	20.10	19.90

LOW CHANNEL

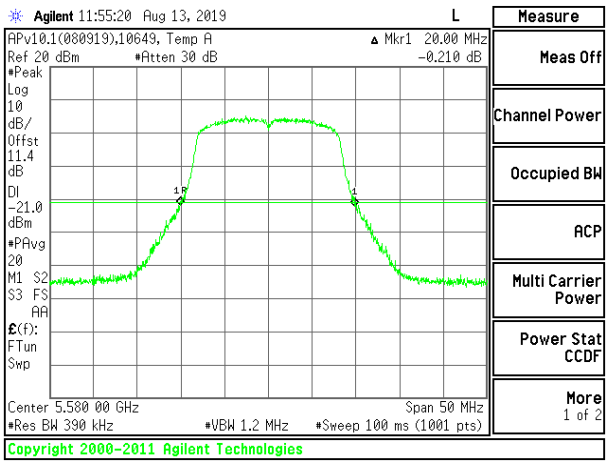


LOW CHANNEL CHAIN 0

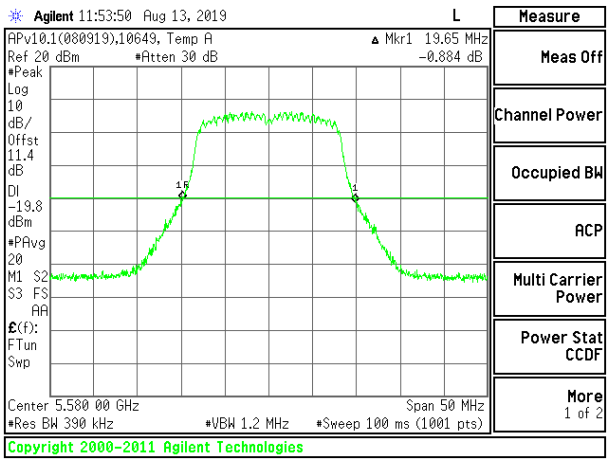


LOW CHANNEL CHAIN 1

MID CHANNEL



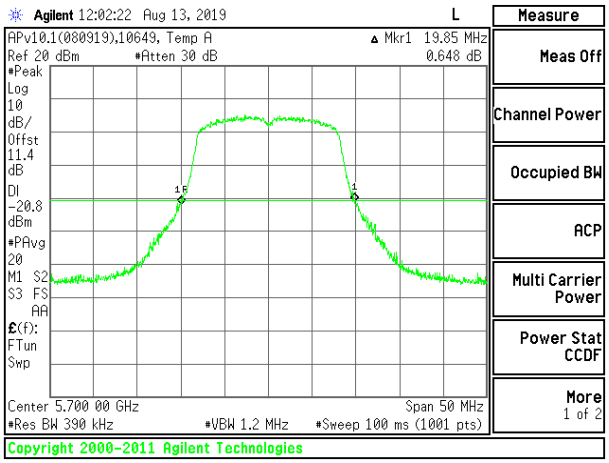
MID CHANNEL CHAIN 0



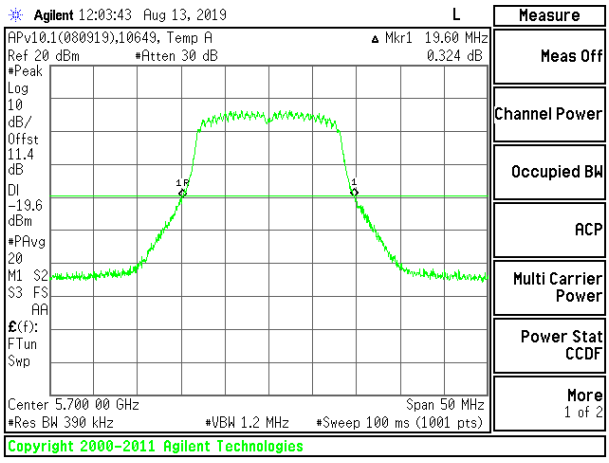
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL

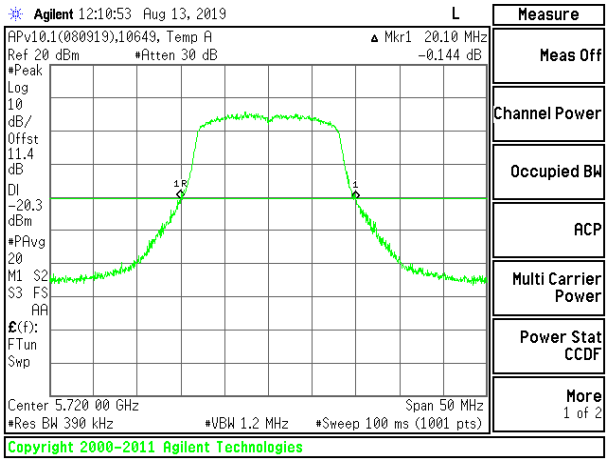


HIGH CHANNEL CHAIN 0

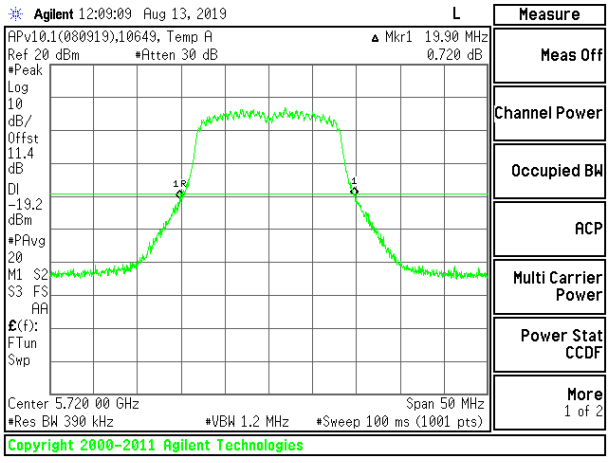


HIGH CHANNEL CHAIN 1

CHANNEL 144



CHANNEL 144 CHAIN 0



CHANNEL 144 CHAIN 1

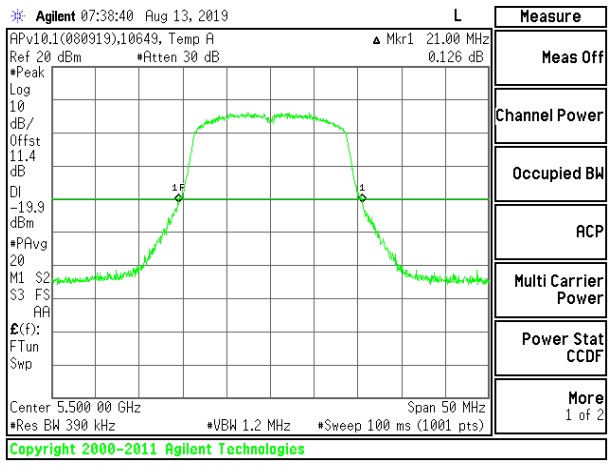
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.10. 802.11n HT20 MODE IN THE 5.6 GHz BAND

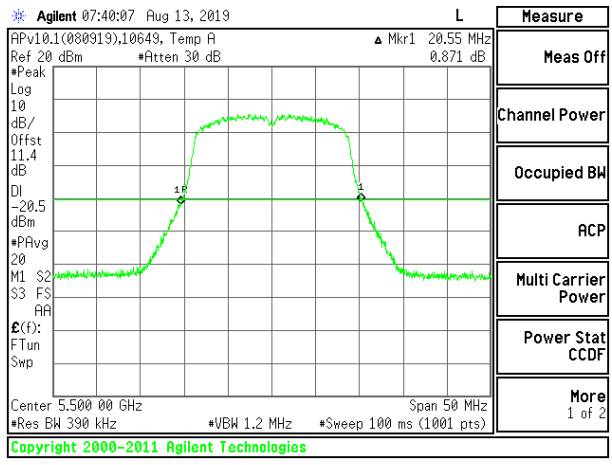
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5500	21.00	20.55
Mid	5580	20.55	20.55
High	5700	20.55	20.45
144	5720	20.45	20.50

LOW CHANNEL

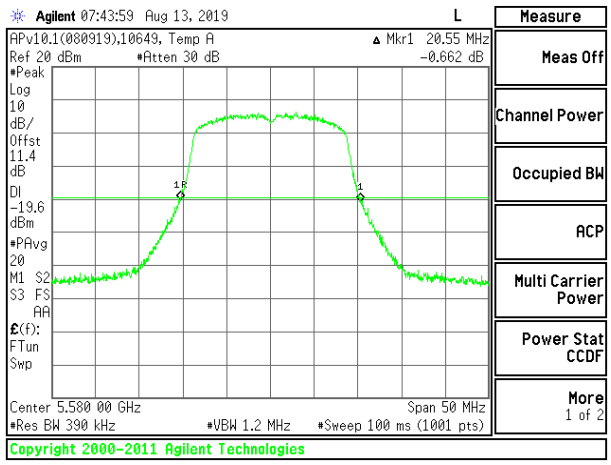


LOW CHANNEL CHAIN 0

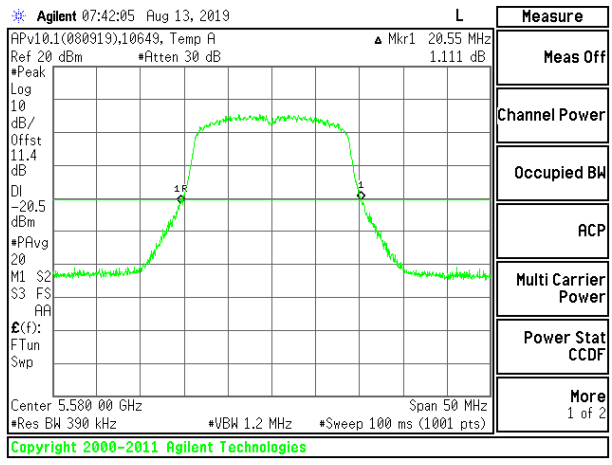


LOW CHANNEL CHAIN 1

MID CHANNEL



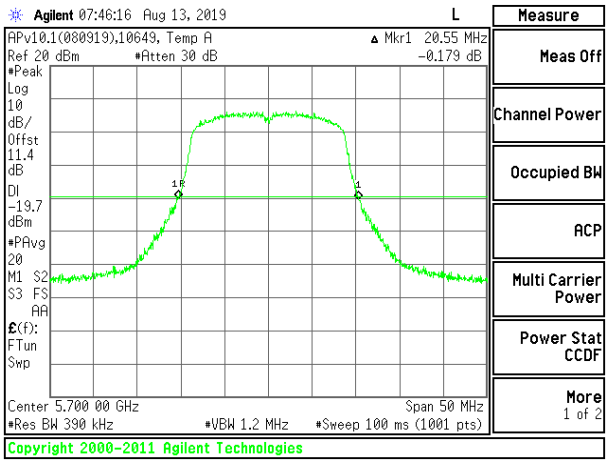
MID CHANNEL CHAIN 0



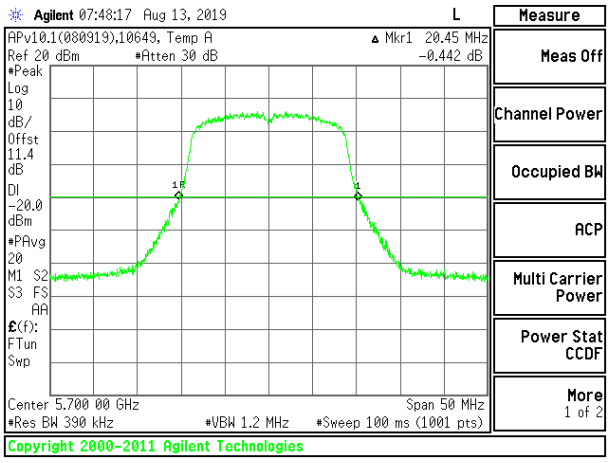
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL

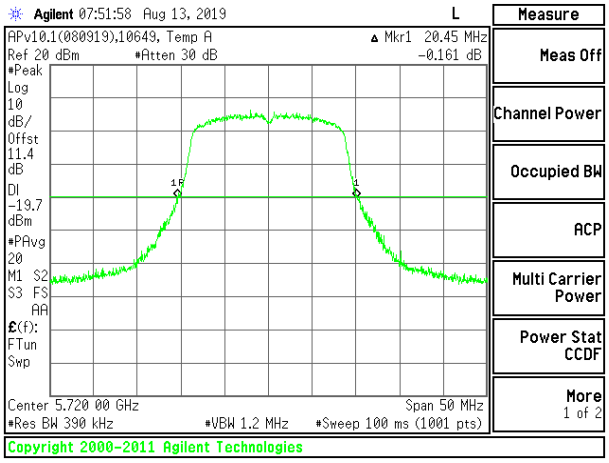


HIGH CHANNEL CHAIN 0

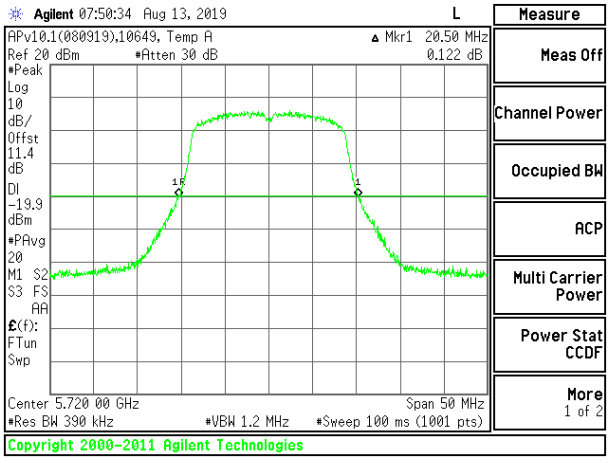


HIGH CHANNEL CHAIN 1

CHANNEL 144



CHANNEL 144 CHAIN 0



CHANNEL 144 CHAIN 1

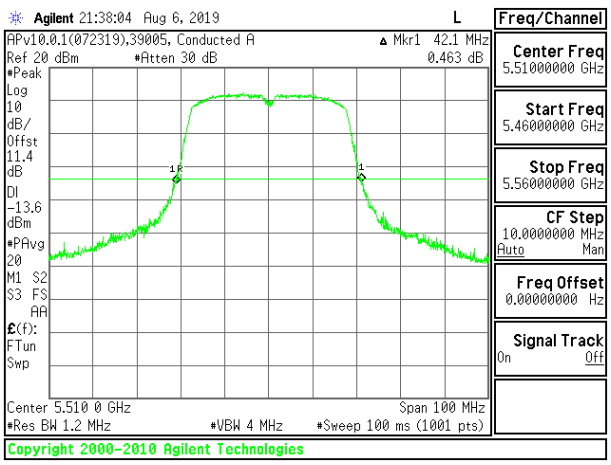
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.11. 802.11n HT40 MODE IN THE 5.6 GHz BAND

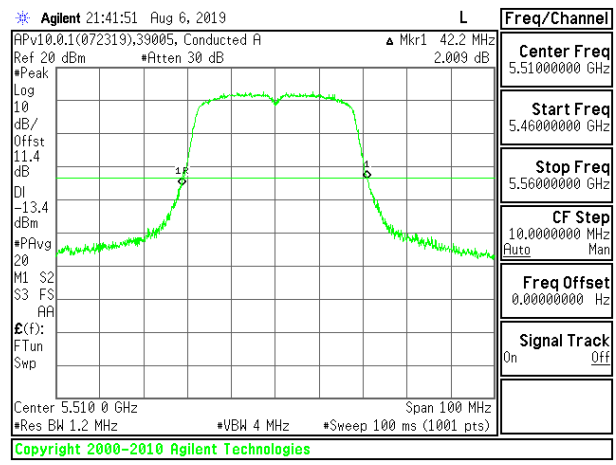
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5510	42.10	42.20
Mid	5550	42.00	42.20
High	5670	42.50	41.90
142	5710	42.30	41.60

LOW CHANNEL

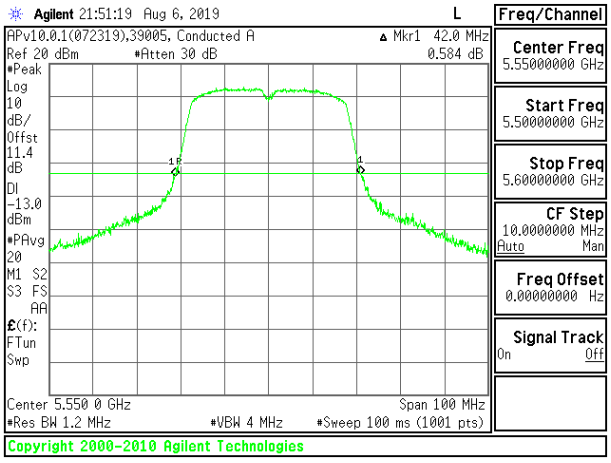


LOW CHANNEL CHAIN 0

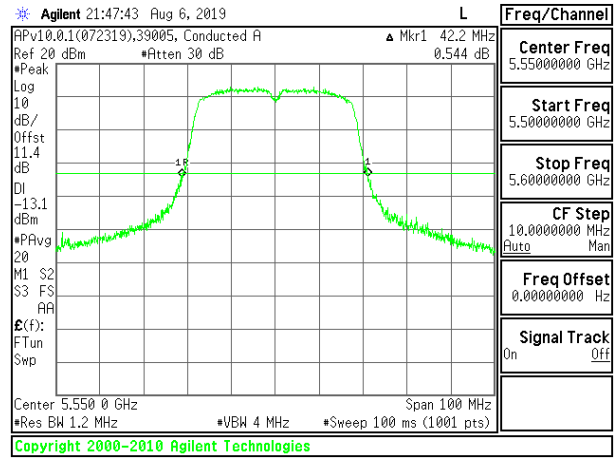


LOW CHANNEL CHAIN 1

MID CHANNEL



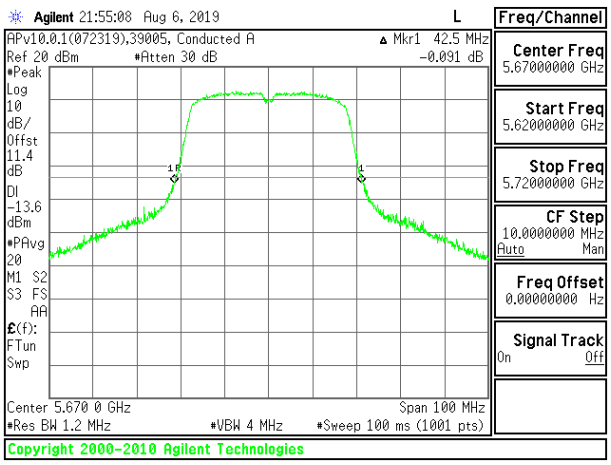
MID CHANNEL CHAIN 0



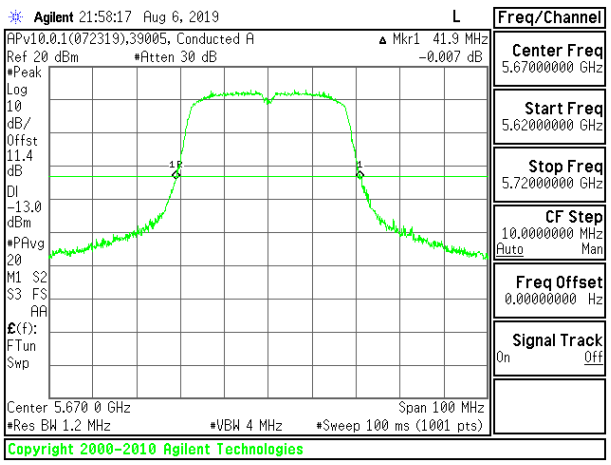
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL

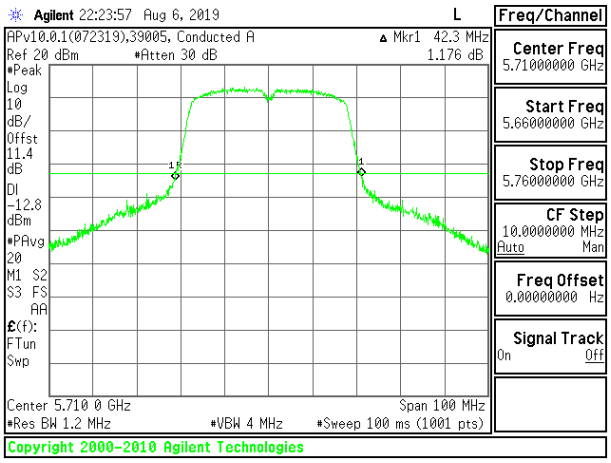


HIGH CHANNEL CHAIN 0

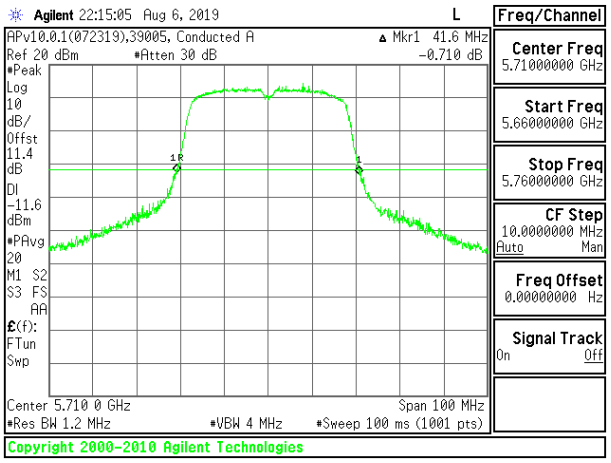


HIGH CHANNEL CHAIN 1

CHANNEL 142



CHANNEL 142 CHAIN 0



CHANNEL 142 CHAIN 1

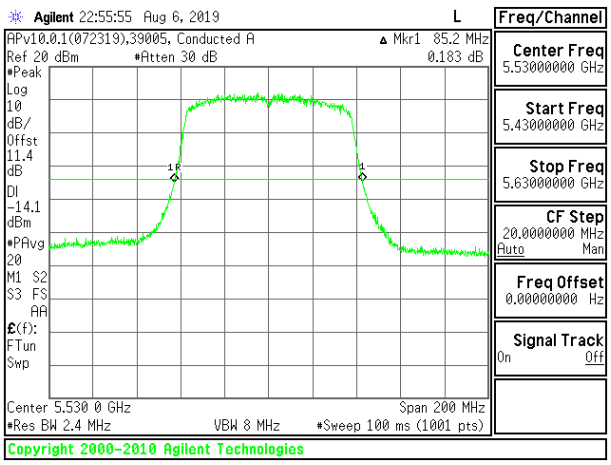
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.12. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND

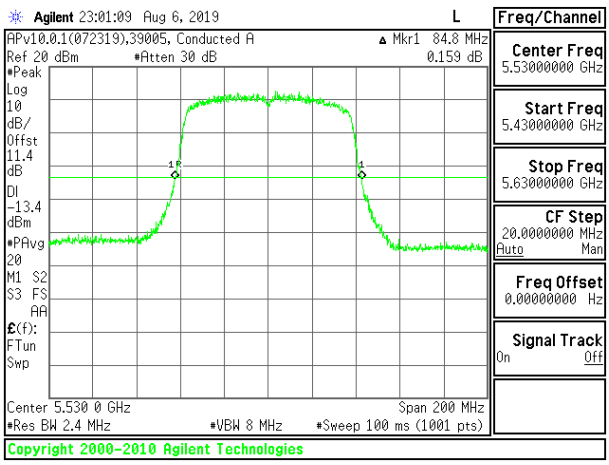
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5530	85.20	84.80
High	5610	85.40	84.80
138	5690	88.20	85.00

LOW CHANNEL

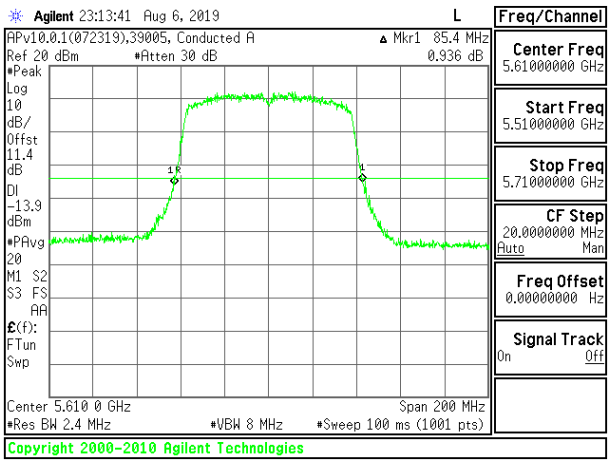


LOW CHANNEL CHAIN 0

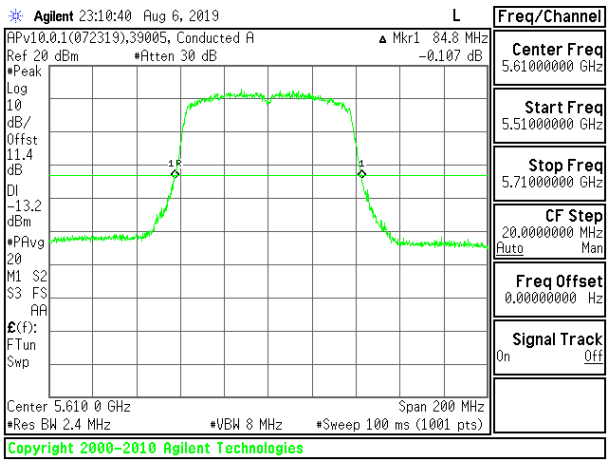


LOW CHANNEL CHAIN 1

HIGH CHANNEL



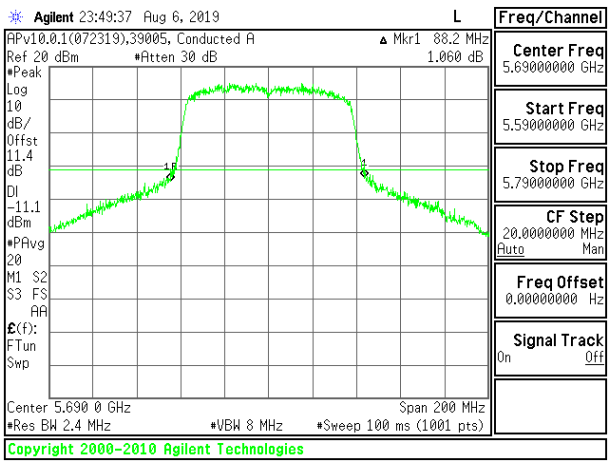
HIGH CHANNEL CHAIN 0



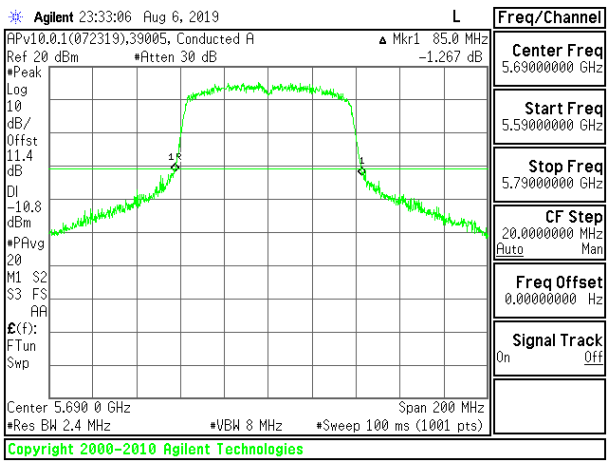
HIGH CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

CHANNEL 138



CHANNEL 138 CHAIN 0



CHANNEL 138 CHAIN 1

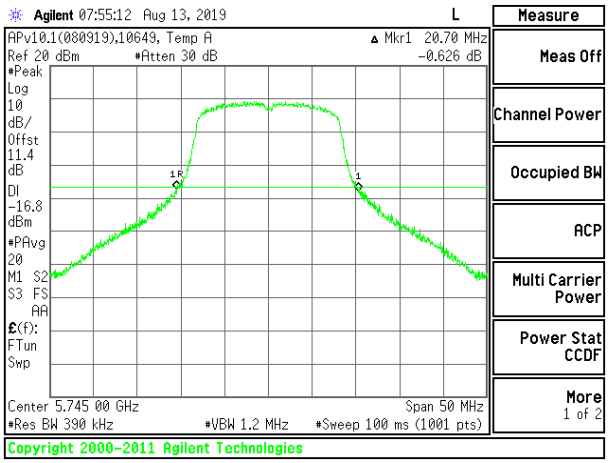
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.13. 802.11a MODE IN THE 5.8 GHz BAND

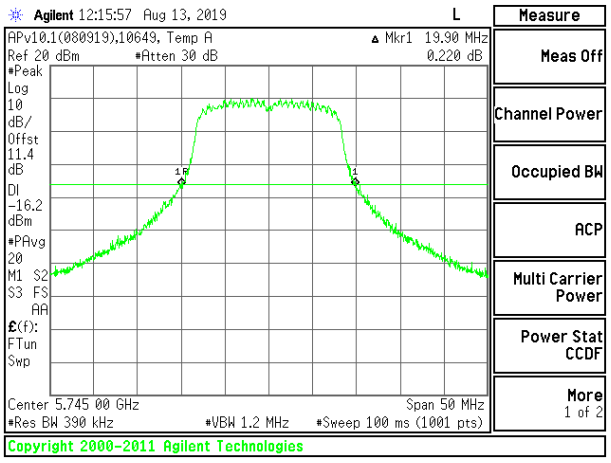
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5745	20.70	19.90
Mid	5785	21.35	19.85
High	5825	20.70	20.50

LOW CHANNEL

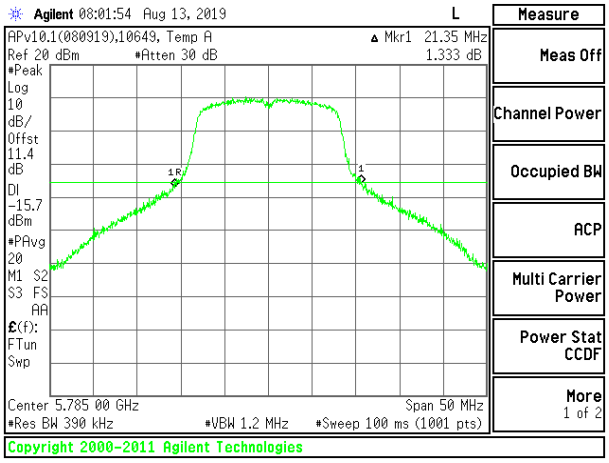


LOW CHANNEL CHAIN 0

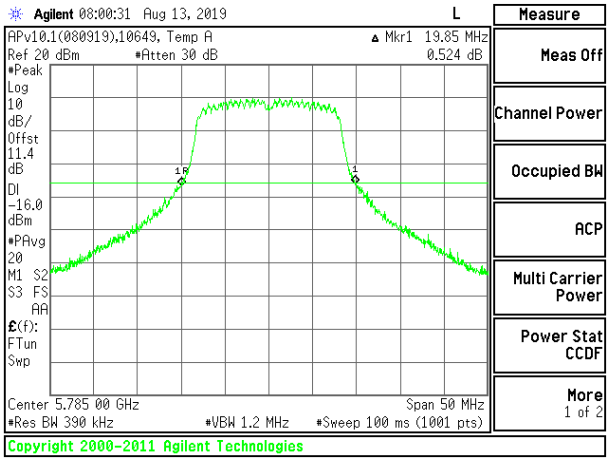


LOW CHANNEL CHAIN 1

MID CHANNEL



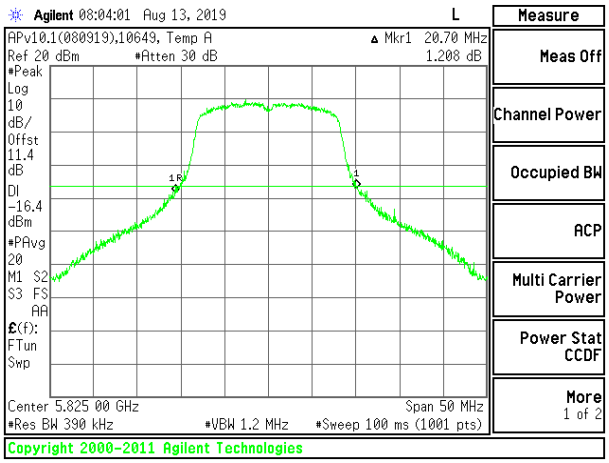
MID CHANNEL CHAIN 0



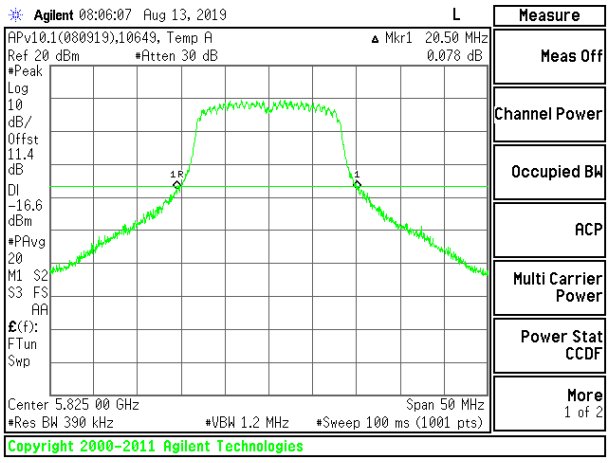
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

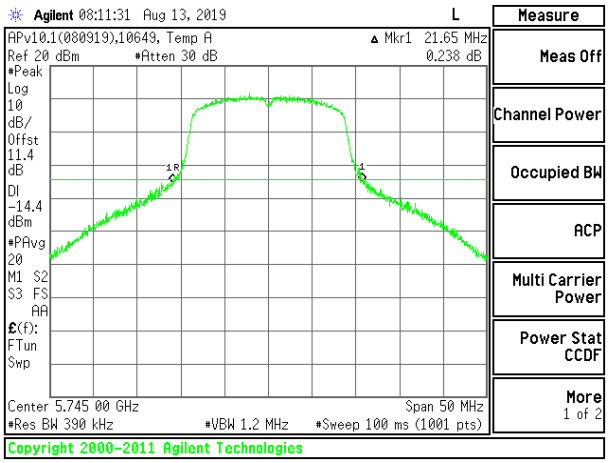
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.14. 802.11n HT20 MODE IN THE 5.8 GHz BAND

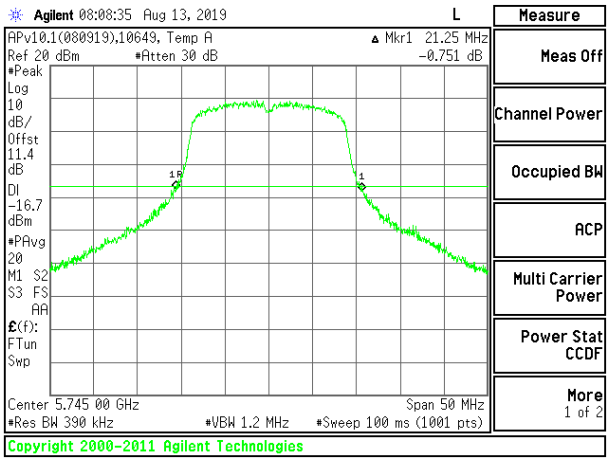
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5745	21.65	21.25
Mid	5785	21.00	21.25
High	5825	21.05	21.50

LOW CHANNEL

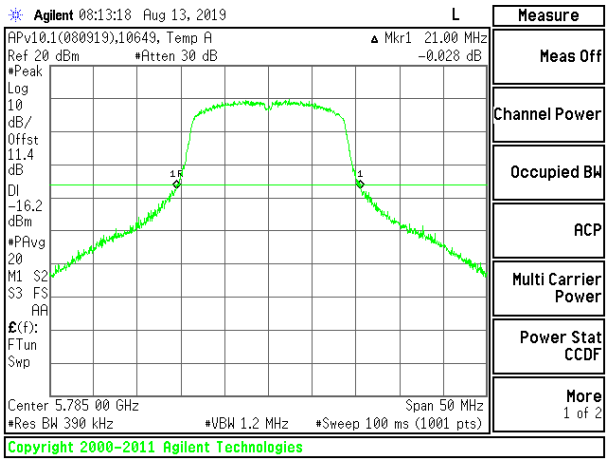


LOW CHANNEL CHAIN 0

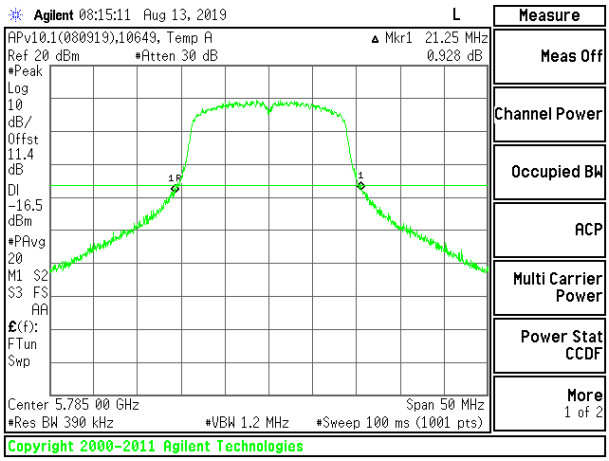


LOW CHANNEL CHAIN 1

MID CHANNEL



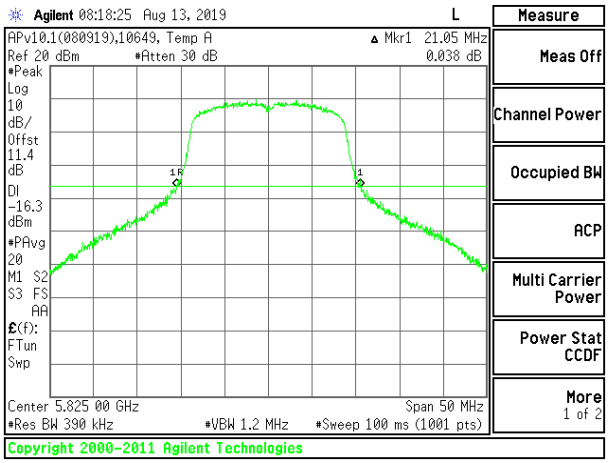
MID CHANNEL CHAIN 0



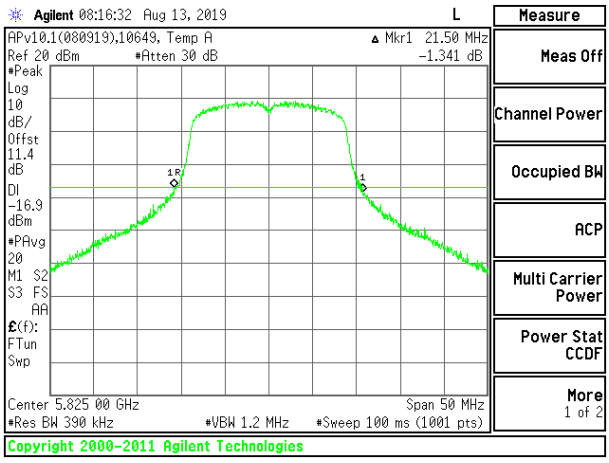
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

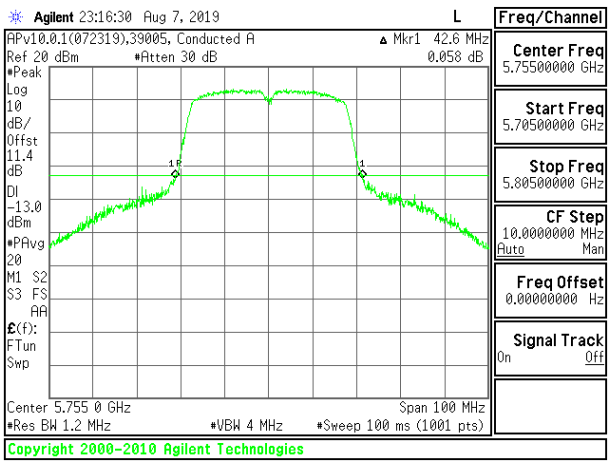
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.15. 802.11n HT40 MODE IN THE 5.8 GHz BAND

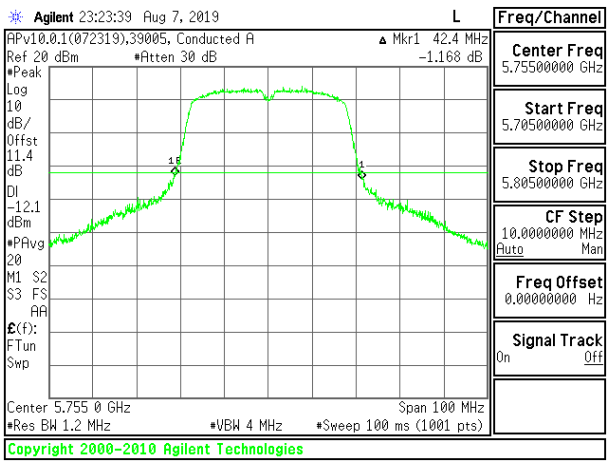
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Low	5755	42.60	42.40
High	5795	42.90	42.50

LOW CHANNEL

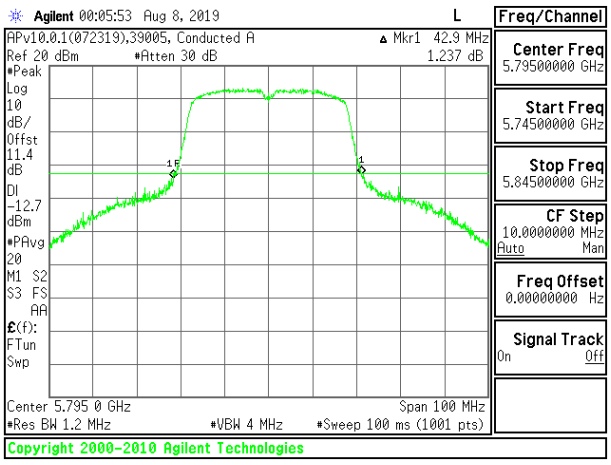


LOW CHANNEL CHAIN 0

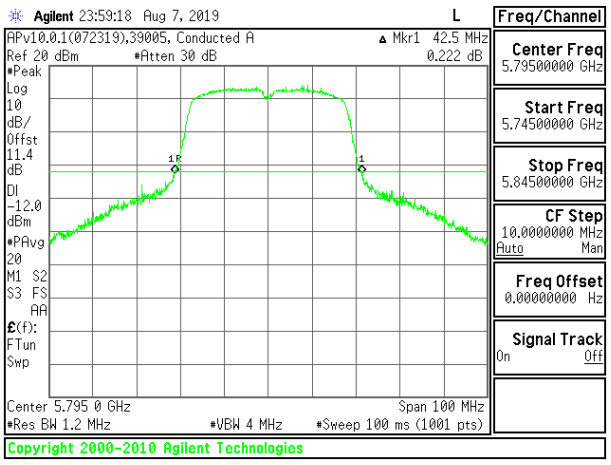


LOW CHANNEL CHAIN 1

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

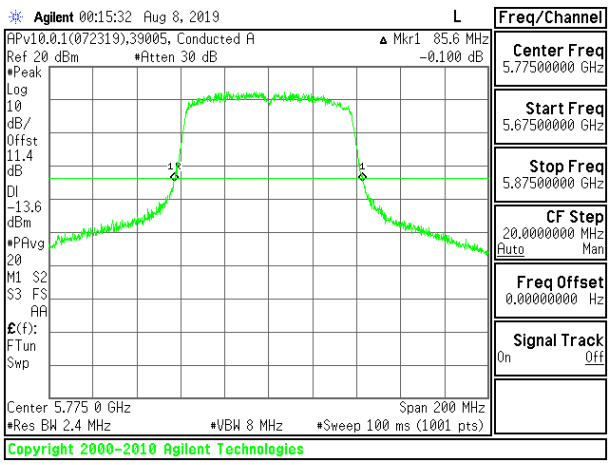
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.16. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND

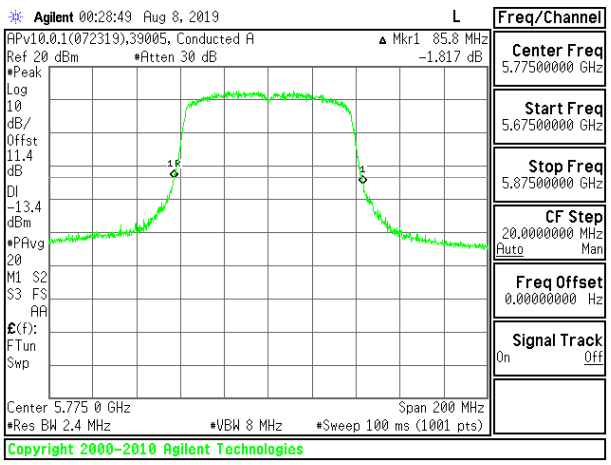
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Chain 0 (MHz)	26 dB Bandwidth Chain 1 (MHz)
Mid	5775	85.60	85.80

MID CHANNEL



MID CHANNEL CHAIN 0



MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

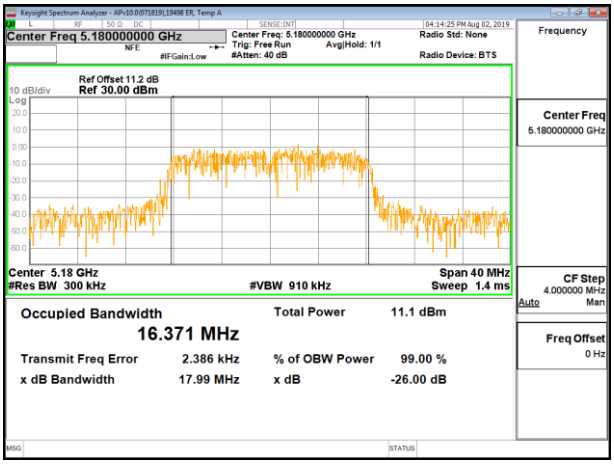
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.1. 802.11a MODE IN THE 5.2 GHz BAND

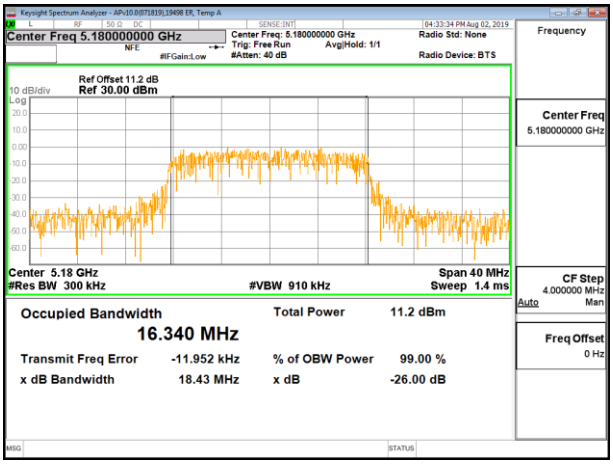
2TX Antenna 1 + Antenna 2 CDD MODE

Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)
Low	5180	16.371	16.340
Mid	5200	16.385	16.370
High	5240	16.397	16.269

LOW CHANNEL

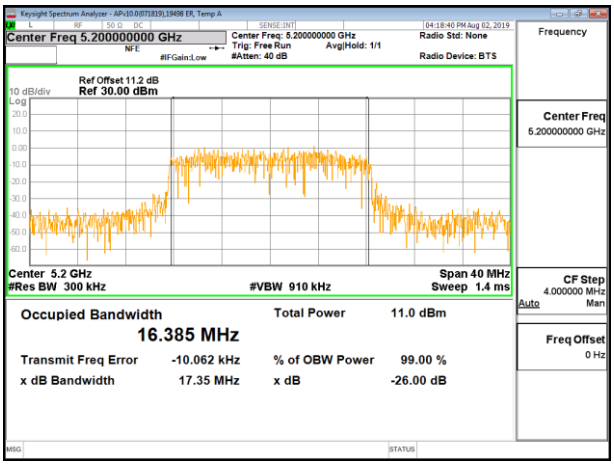


LOW CHANNEL CHAIN 0

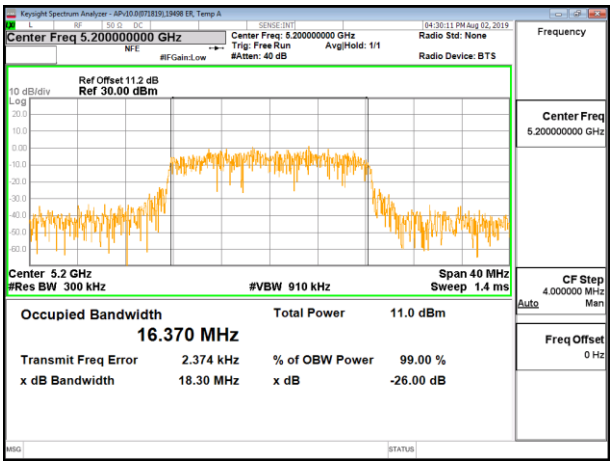


LOW CHANNEL CHAIN 1

MID CHANNEL



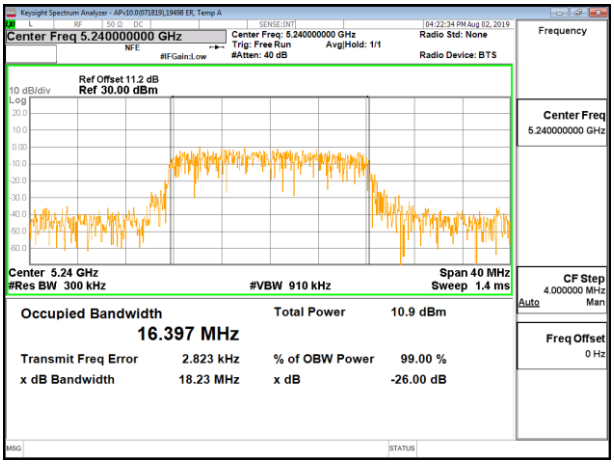
MID CHANNEL CHAIN 0



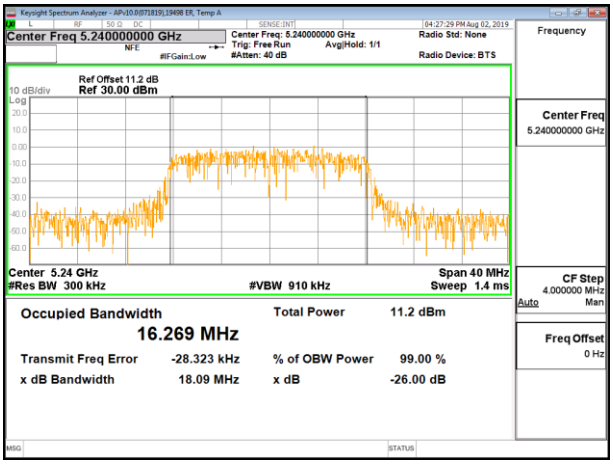
MID CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL



HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.