



CERTIFICATION TEST REPORT

Report Number. : 12696946-E4V2

Applicant : APPLE, INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

Model : A2111, A2222 AND A2223

FCC ID : BCG-E3309A

EUT Description : SMARTPHONE

Test Standard(s) : FCC 47 CFR PART 15 SUBPART E

Date Of Issue:
August 05, 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	7/18/2019	Initial Issue	Francisco Guarnero
V2	8/5/2019	Addressed TCB Questions for sections 2, 5.2, 6, 8, 8.3	Tony Li

TABLE OF CONTENTS

REPORT REVISION HISTORY	2
TABLE OF CONTENTS	3
1. ATTESTATION OF TEST RESULTS	6
2. TEST METHODOLOGY	7
3. FACILITIES AND ACCREDITATION	7
4. CALIBRATION AND UNCERTAINTY	8
4.1. MEASURING INSTRUMENT CALIBRATION	8
4.2. SAMPLE CALCULATION	8
4.3. MEASUREMENT UNCERTAINTY	8
5. EQUIPMENT UNDER TEST	9
5.1. EUT DESCRIPTION	9
5.2. MAXIMUM OUTPUT POWER.....	9
5.3. DESCRIPTION OF AVAILABLE ANTENNAS	13
5.4. SOFTWARE AND FIRMWARE.....	13
5.5. WORST-CASE CONFIGURATION AND MODE.....	13
5.6. DESCRIPTION OF TEST SETUP.....	15
6. MEASUREMENT METHOD.....	20
7. TEST AND MEASUREMENT EQUIPMENT	21
8. ANTENNA PORT TEST RESULTS	22
8.1. ON TIME AND DUTY CYCLE.....	22
8.2. 26 dB BANDWIDTH.....	27
8.2.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND	28
8.2.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND	32
8.2.3. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND	34
8.2.4. 802.11ax HE20 MODE IN THE 5.2 GHz BAND	36
8.2.5. 802.11ax HE40 MODE IN THE 5.2 GHz BAND	52
8.2.6. 802.11ax HE80 MODE IN THE 5.2 GHz BAND	60
8.2.7. 802.11n HT20 MODE IN THE 5.3 GHz BAND	66
8.2.8. 802.11n HT40 MODE IN THE 5.3 GHz BAND	70
8.2.9. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND	72
8.2.10. 802.11ax HE20 MODE IN THE 5.3 GHz BAND	74
8.2.11. 802.11ax HE40 MODE IN THE 5.3 GHz BAND	90
8.2.12. 802.11ax HE80 MODE IN THE 5.3 GHz BAND	98
8.2.13. 802.11n HT20 MODE IN THE 5.6 GHz BAND	104
8.2.14. 802.11n HT40 MODE IN THE 5.6 GHz BAND	108

8.2.15.	802.11ac VHT80 MODE IN THE 5.6 GHz BAND	112
8.2.16.	802.11ax HE20 MODE IN THE 5.6 GHz BAND	116
8.2.17.	802.11ax HE40 MODE IN THE 5.6 GHz BAND	132
8.2.18.	802.11ax HE80 MODE IN THE 5.6 GHz BAND	148
8.2.19.	802.11n HT20 MODE IN THE 5.8 GHz BAND	164
8.2.20.	802.11n HT40 MODE IN THE 5.8 GHz BAND	168
8.2.21.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND	170
8.2.22.	802.11ax HE20 MODE IN THE 5.8 GHz BAND	172
8.2.23.	802.11ax HE40 MODE IN THE 5.8 GHz BAND	188
8.2.24.	802.11ax HE80 MODE IN THE 5.8 GHz BAND	196
8.3.	99% BANDWIDTH.....	202
8.3.1.	802.11n HT20 MODE IN THE 5.2 GHz BAND	203
8.3.2.	802.11n HT40 MODE IN THE 5.2 GHz BAND	207
8.3.3.	802.11ac VHT80 MODE IN THE 5.2 GHz BAND	209
8.3.4.	802.11ax HE20 MODE IN THE 5.2 GHz BAND	211
8.3.5.	802.11ax HE40 MODE IN THE 5.2 GHz BAND	227
8.3.6.	802.11ax HE80 MODE IN THE 5.2 GHz BAND	235
8.3.7.	802.11n HT20 MODE IN THE 5.3 GHz BAND	241
8.3.8.	802.11n HT40 MODE IN THE 5.3 GHz BAND	245
8.3.9.	802.11ac VHT80 MODE IN THE 5.3 GHz BAND	247
8.3.10.	802.11ax HE20 MODE IN THE 5.3 GHz BAND	249
8.3.11.	802.11ax HE40 MODE IN THE 5.3 GHz BAND	265
8.3.12.	802.11ax HE80 MODE IN THE 5.3 GHz BAND	273
8.3.13.	802.11n HT20 MODE IN THE 5.6 GHz BAND	279
8.3.14.	802.11n HT40 MODE IN THE 5.6 GHz BAND	283
8.3.15.	802.11ac VHT80 MODE IN THE 5.6 GHz BAND	287
8.3.16.	802.11ax HE20 MODE IN THE 5.6 GHz BAND	291
8.3.17.	802.11ax HE40 MODE IN THE 5.6 GHz BAND	307
8.3.18.	802.11ax HE80 MODE IN THE 5.6 GHz BAND	323
8.3.19.	802.11n HT20 MODE IN THE 5.8 GHz BAND	339
8.3.20.	802.11n HT40 MODE IN THE 5.8 GHz BAND	343
8.3.21.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND	345
8.3.22.	802.11ax HE20 MODE IN THE 5.8 GHz BAND	347
8.3.23.	802.11ax HE40 MODE IN THE 5.8 GHz BAND	363
8.3.24.	802.11ax HE80 MODE IN THE 5.8 GHz BAND	372
8.4.	6 dB BANDWIDTH.....	378
8.4.1.	802.11n HT20 MODE IN THE 5.8 GHz BAND	378
8.4.2.	802.11n HT40 MODE IN THE 5.8 GHz BAND	383
8.4.3.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND	387
8.4.4.	802.11ax HE20 MODE IN THE 5.8 GHz BAND	389
8.4.5.	802.11ax HE40 MODE IN THE 5.8 GHz BAND	405
8.4.6.	802.11ax HE80 MODE IN THE 5.8 GHz BAND	421
8.5.	OUTPUT POWER AND PSD.....	430
8.5.1.	802.11n HT20 MODE IN THE 5.2 GHz BAND	432
8.5.2.	802.11n HT40 MODE IN THE 5.2 GHz BAND	438
8.5.3.	802.11ac VHT80 MODE IN THE 5.2 GHz BAND	444
8.5.4.	802.11ax HE20 MODE IN THE 5.2 GHz BAND	450
8.5.5.	802.11ax HE40 MODE IN THE 5.2 GHz BAND	472
8.5.6.	802.11ax HE80 MODE IN THE 5.2 GHz BAND	496
8.5.7.	802.11n HT20 MODE IN THE 5.3 GHz BAND	516
8.5.8.	802.11n HT40 MODE IN THE 5.3 GHz BAND	522

8.5.9.	802.11ac VHT80 MODE IN THE 5.3 GHz BAND	526
8.5.10.	802.11ax HE20 MODE IN THE 5.3 GHz BAND	529
8.5.11.	802.11ax HE40 MODE IN THE 5.3 GHz BAND	553
8.5.12.	802.11ax HE80 MODE IN THE 5.3 GHz BAND	569
8.5.13.	802.11n HT20 MODE IN THE 5.6 GHz BAND	583
8.5.14.	802.11n HT40 MODE IN THE 5.6 GHz BAND	590
8.5.15.	802.11ac VHT80 MODE IN THE 5.6 GHz BAND	597
8.5.16.	802.11ax HE20 MODE IN THE 5.6 GHz BAND	603
8.5.17.	802.11ax HE40 MODE IN THE 5.6 GHz BAND	631
8.5.18.	802.11ax HE80 MODE IN THE 5.6 GHz BAND	659
8.5.19.	802.11n HT20 MODE IN THE 5.8 GHz BAND	683
8.5.20.	802.11n HT40 MODE IN THE 5.8 GHz BAND	690
8.5.21.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND	697
8.5.22.	802.11ax HE20 MODE IN THE 5.8 GHz BAND	703
8.5.23.	802.11ax HE40 MODE IN THE 5.8 GHz BAND	731
8.5.24.	802.11ax HE80 MODE IN THE 5.8 GHz BAND	759

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: SMARTPHONE

MODEL: A2111, A2222 AND A2223

SERIAL NUMBER: C7CYQ004MT74; C7CYP0L2MT5Q

DATE TESTED: March 7, 2019 - July 26, 2019

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart E	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.

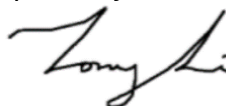
This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This 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.

Approved & Released For
UL Verification Services Inc. By:



Chin Pang
Senior Engineer
Consumer Technology Division
UL Verification Services Inc.

Prepared By:



Tony Li
Test Engineer
Consumer Technology Division
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, ANSI C63.10-2013, FCC 06-96.

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 Rd
☒ Chamber A (ISED:2324B-1)	☒ Chamber D (ISED:22541-1)	☐ Chamber I (ISED:2324A-5)
☒ Chamber B (ISED:2324B-2)	☐ Chamber E (ISED:22541-2)	☐ Chamber J (ISED:2324A-6)
☐ Chamber C (ISED:2324B-3)	☐ Chamber F (ISED:22541-3)	☐ Chamber K (ISED:2324A-1)
	☐ Chamber G (ISED:22541-4)	☐ Chamber L (ISED:2324A-3)
	☒ Chamber H (ISED:22541-5)	

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

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

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%.

5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wide band, GPS and NFC. All models support at least one UICC based SIM. The second SIM, if present, is either UICC based pSIM (physical SIM) or e-SIM (electronic SIM). The device has a built-in inductive charging receiver. The rechargeable battery is also not user accessible.

1.1. DIFFERENCE IN MODEL NUMBER

Model A2111, A2222 and A2223 is electrically identical to Model A2111. Three model numbers are allocated for marketing and logistic purposes only. A2111 was used to perform all final tests.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

5.2 GHz BAND (FCC)

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.2 GHz band, 1TX			
5180-5240	802.11a	Covered by 802.11n HT20 1TX	
5180-5240	802.11n HT20	20.710	117.76
5190-5230	802.11n HT40	21.200	131.83
5180-5240	802.11ac VHT20	Covered by 802.11n HT20 1TX	
5190-5230	802.11ac VHT40	Covered by 802.11n HT40 1TX	
5210	802.11ac VHT80	17.190	52.36
5180-5240	802.11ax HE20	20.710	117.76
5190-5230	802.11ax HE40	21.200	131.83
5210	802.11ax HE80	15.710	37.24
5.2 GHz band, 2TX			
5180-5240	802.11n HT20 CDD	20.640	115.88
5180-5240	802.11n HT20 SDM/STBC	Covered by 802.11n HT20 2TX CDD	
5190-5230	802.11n HT40 CDD	22.670	184.93
5190-5230	802.11n HT40 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5180-5240	802.11ac VHT20 SDM/STBC/CDD	Covered by 802.11n HT20 2TX CDD	
5190-5230	802.11ac VHT40 SDM/STBC/CDD	Covered by 802.11n HT40 2TX CDD	
5210	802.11ac VHT80 CDD	19.220	83.56
5210	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5180-5240	802.11ax HE20 OFDMA	20.705	117.63
5190-5230	802.11ax HE40 OFDMA	22.690	185.78
5210	802.11ax HE80 OFDMA	17.720	59.16

5.3 GHz BAND (FCC)

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.3 GHz band, 1TX			
5260 - 5320	802.11a	Covered by 802.11n HT20 1TX	
5260 - 5320	802.11n HT20	20.700	117.49
5270 - 5310	802.11n HT40	21.100	128.82
5260 - 5320	802.11ac VHT20	Covered by 802.11n HT20 1TX	
5270 - 5310	802.11ac VHT40	Covered by 802.11n HT40 1TX	
5290	802.11ac VHT80	17.240	52.97
5260 - 5320	802.11ax HE20	20.730	118.30
5270 - 5310	802.11ax HE40	21.200	131.83
5290	802.11ax HE80	15.720	37.33
5.3 GHz band, 2TX			
5260 - 5320	802.11n HT20 CDD	20.705	117.63
5260 - 5320	802.11n HT20 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5270 - 5310	802.11n HT40 CDD	22.710	186.64
5270 - 5310	802.11n HT40 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5260 - 5320	802.11ac VHT20 SDM/STBC/CDD	Covered by 802.11n HT20 2TX CDD	
5270 - 5310	802.11ac VHT40 SDM/STBC/CDD	Covered by 802.11n HT40 2TX CDD	
5290	802.11ac VHT80 CDD	19.235	83.85
5290	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5260 - 5320	802.11ax HE20 OFDMA	20.710	117.76
5270 - 5310	802.11ax HE40 OFDMA	22.700	186.21
5290	802.11ax HE80 OFDMA	17.235	52.91

5.6 GHz BAND (FCC)

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.6 GHz band, 1TX			
5500-5720	802.11a	Covered by 802.11n HT20 1TX	
5500-5720	802.11n HT20	20.801	120.25
5510-5710	802.11n HT40	21.210	132.13
5500-5720	802.11ac VHT20	Covered by 802.11n HT20 1TX	
5510-5710	802.11ac VHT40	Covered by 802.11n HT40 1TX	
5530-5690	802.11ac VHT80	21.339	136.11
5500-5720	802.11ax HE20	20.740	118.58
5510-5710	802.11ax HE40	21.250	133.35
5530-5690	802.11ax HE80	21.630	145.55
5.6 GHz band, 2TX			
5500-5720	802.11n HT20 CDD	20.914	123.42
5500-5720	802.11n HT20 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5510-5710	802.11n HT40 CDD	22.669	184.88
5510-5710	802.11n HT40 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5500-5720	802.11ac VHT20 SDM/STBC/CDD	Covered by 802.11n HT20 2TX CDD	
5510-5710	802.11ac VHT40 SDM/STBC/CDD	Covered by 802.11n HT40 2TX CDD	
5530-5690	802.11ac VHT80 CDD	22.915	195.66
5530-5690	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5500-5720	802.11ax HE20 OFDMA	20.948	124.39
5510-5710	802.11ax HE40 OFDMA	22.618	182.73
5530-5690	802.11ax HE80 OFDMA	22.628	183.15

5.8 GHz BAND (FCC)

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.8 GHz band, 1TX			
5745-5825	802.11a	Covered by 802.11n HT20 1TX	
5745-5825	802.11n HT20	21.200	131.83
5755-5795	802.11n HT40	21.170	130.92
5745-5825	802.11ac VHT20	Covered by 802.11n HT20 1TX	
5755-5795	802.11ac VHT40	Covered by 802.11n HT40 1TX	
5775	802.11ac VHT80	21.470	140.28
5745-5825	802.11ax HE20	21.230	132.74
5755-5795	802.11ax HE40	21.220	132.43
5775	802.11ax HE80	21.180	131.22
5.8 GHz band, 2TX			
5745-5825	802.11n HT20 CDD	24.225	264.55
5745-5825	802.11n HT20 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5755-5795	802.11n HT40 CDD	24.210	263.63
5755-5795	802.11n HT40 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5745-5825	802.11ac VHT20 STM/STBC/CDD	Covered by 802.11n HT20 2TX CDD	
5755-5795	802.11ac VHT40 STM/STBC/CDD	Covered by 802.11n HT40 2TX CDD	
5775	802.11ac VHT80 CDD	24.450	278.61
5775	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5745-5825	802.11ax HE20 OFDMA	24.230	264.85
5755-5795	802.11ax HE40 OFDMA	24.225	264.55
5775	802.11ax HE80 OFDMA	23.175	207.73

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range	Antenna 4 (Core 0)	Antenna 5 (Core 1)
5180 - 5240	-6.0	-1.1
5260 – 5320	-5.8	-1.3
5500 - 5720	-4.0	-1.2
5745 - 5825	-4.1	-1.7

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was WiFi FW Version: 18_20_56_1

5.5. WORST-CASE CONFIGURATION AND MODE

The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z on Ant 4 (Core 0) and Ant 5 (Core 1). It was determined that Z (Portrait) orientation was the worst-case orientation for Ant 4; and Y (Landscape) orientation was the worst case for Ant 5 and Z (Portrait) for 2TX.

For radiated harmonics spurious below 1GHz, 1-18GHz L/M/H channels, 18-40GHz, and power line conducted emissions were performed with the EUT set at the 2TX CDD mode among the CDD/SDM modes with power setting equal or higher than SISO modes as worst-case scenario.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT was set to transmit at highest power on Low/Middle/High channels.

Below 1GHz tests were performed with EUT connected to AC power adapter as the worst case; and for above 1GHz, the worst-case configuration reported was tested with EUT only. For AC line conducted emission, test was investigated with AC power adapter and with laptop.

There were no emissions found below 30MHz within 20dB of the limit.

The output power and psd for the 802.11 ax mode were investigated between all different tones, and we found that the highest tone had the highest output power and lowest tone had the highest PSD readings. Therefore, full testing was performed on both the highest and lowest tones.

For simultaneous transmission with the Bluetooth was investigated, no noticeable emission was found.

Investigated worst-case data rates as listed below were:

802.11n HT20mode: MCS0
802.11n HT40mode: MCS0
802.11ac VHT80 mode: MCS0
802.11ax HE20/HE40/HE80 FULL RU & RU26

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
laptop	Apple	Macbook Pro	C02P41RZG086	FCC DoC
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA
EUT AC Adapter	Apple	A1385	D292365CDYADHLHC3	NA

I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1	N/A
3	AC	1	AC	Un-shielded	2	N/A

I/O CABLES (RADIATED ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
NA						

I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

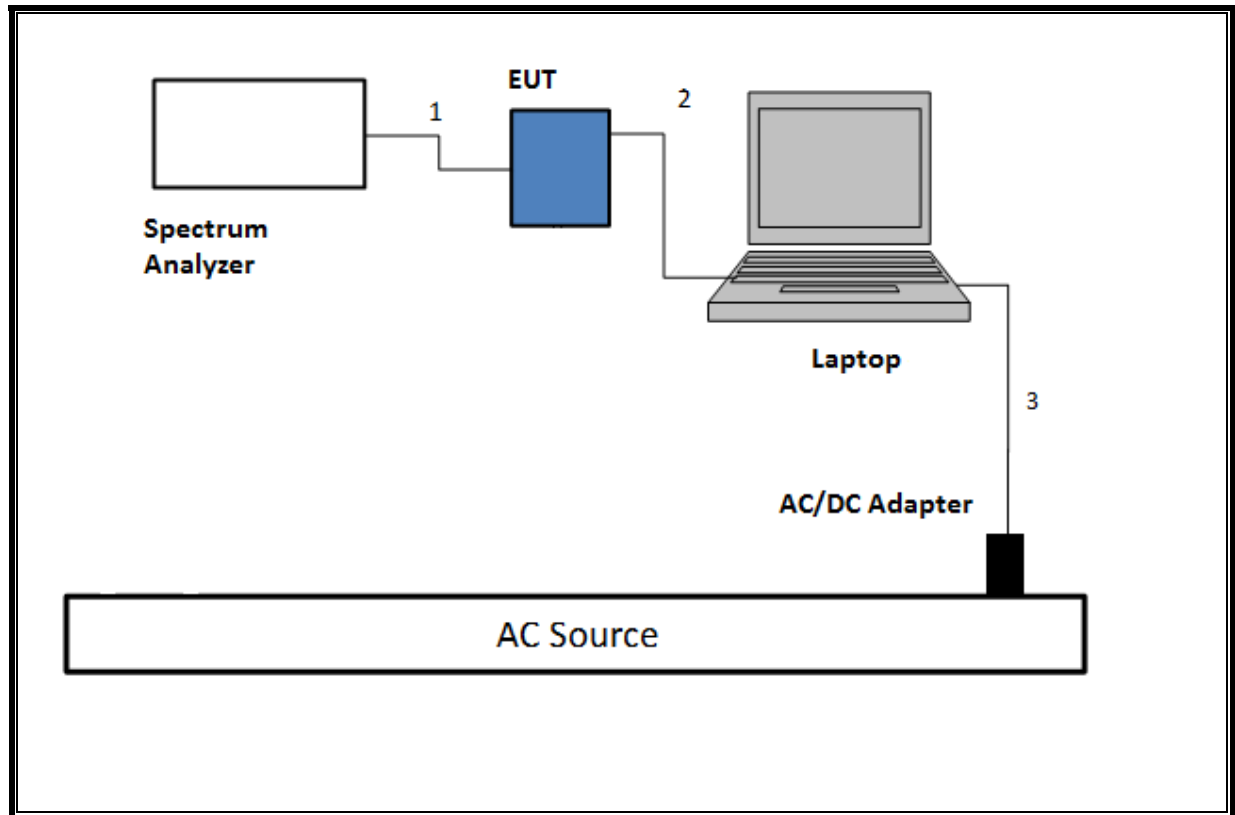
I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Shielded	1	N/A

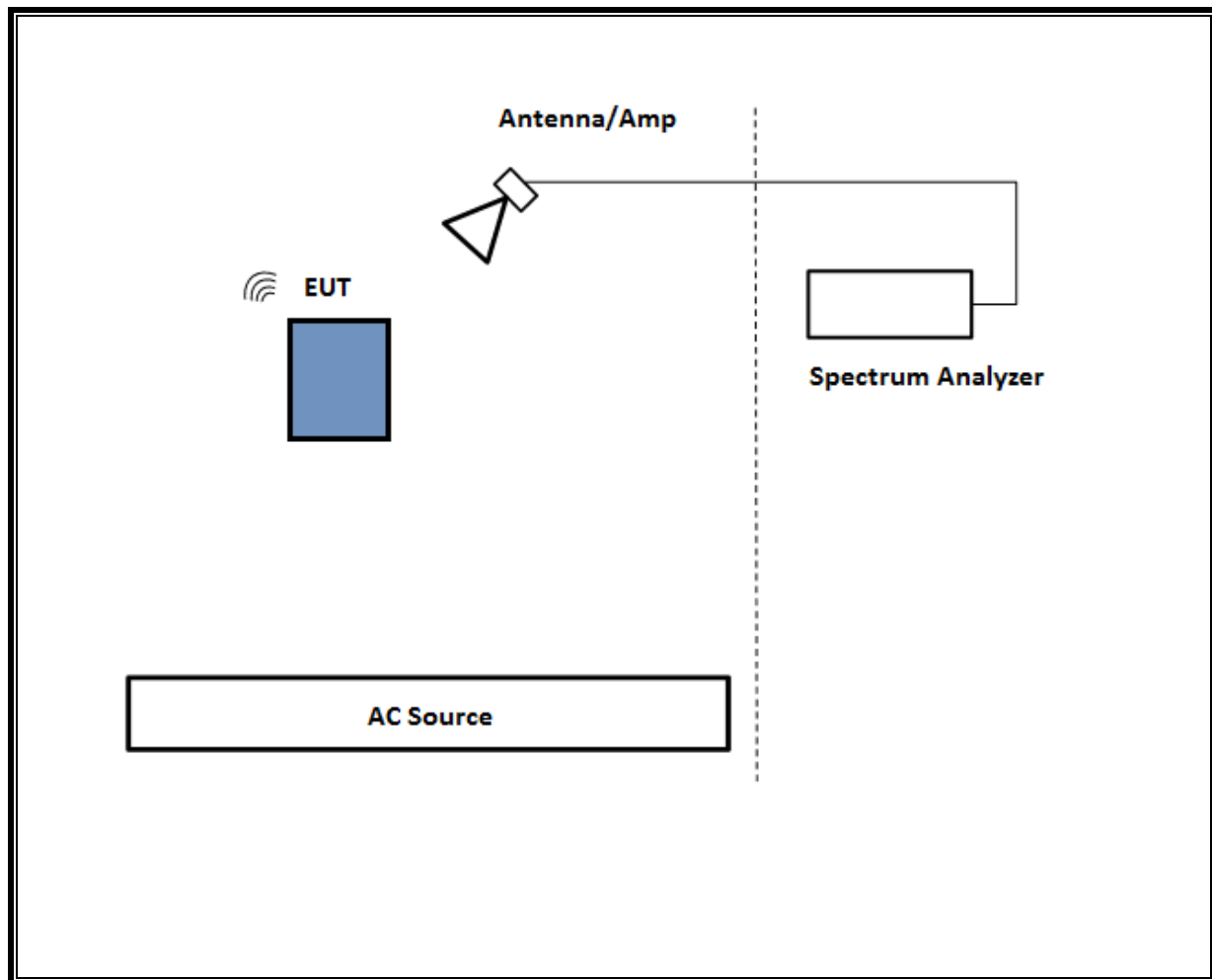
TEST SETUP

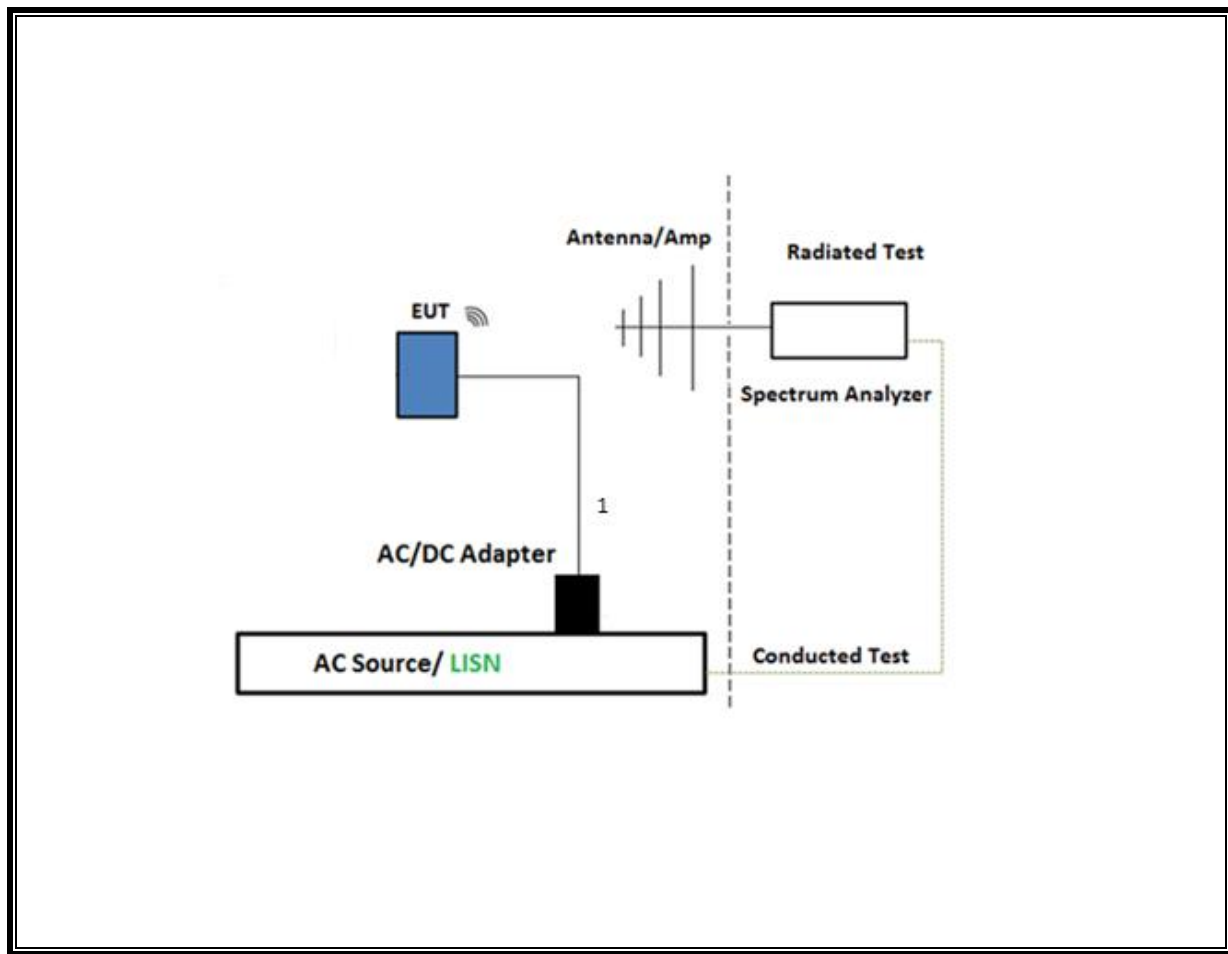
The EUT is installed in a host laptop computer during the tests. Test software exercised the radio card.

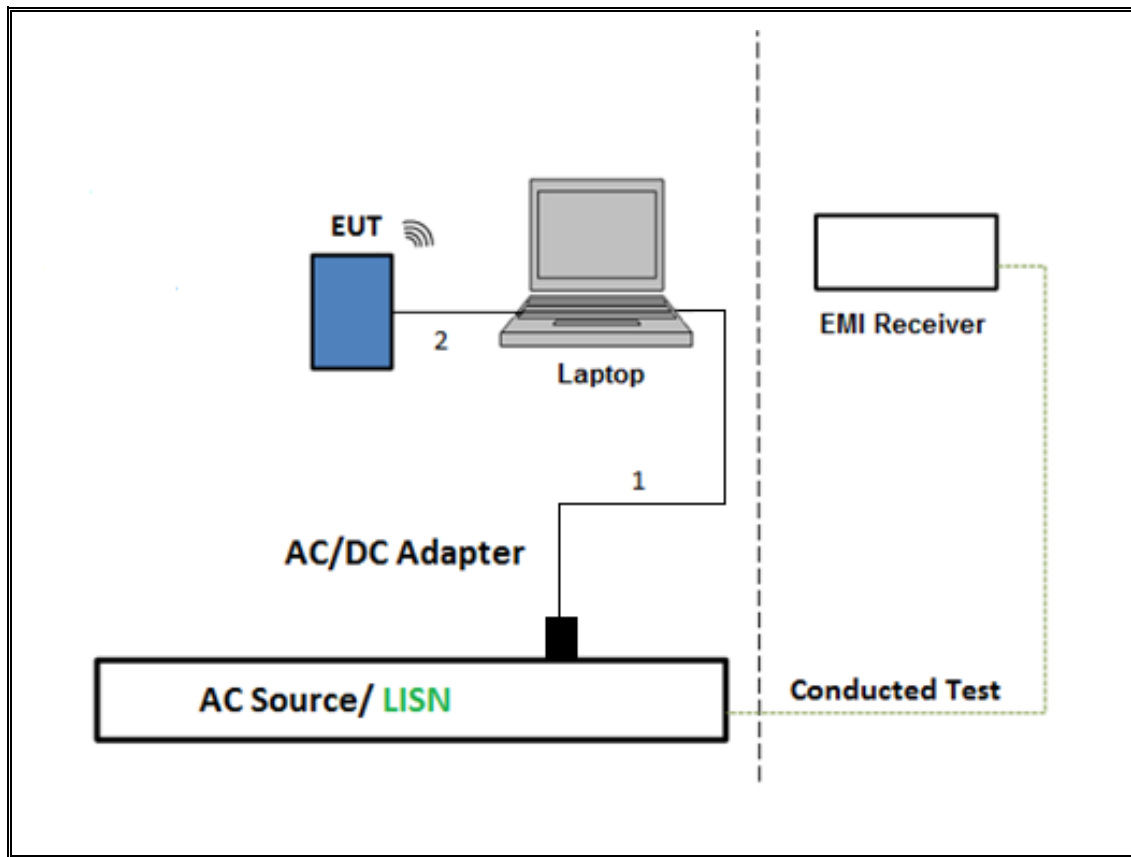
TEST SETUP - CONDUCTED TESTS

The EUT was tested connected to a host Laptop via USB cable adapter and spectrum analyzer to antenna port. Test software exercised the EUT.

SETUP DIAGRAM

SETUP DIAGRAM FOR RADIATED TESTS Above 1GHz

SETUP DIAGRAM FOR Below 1GHz and AC LINE CONDUCTED TEST

TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION

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), Section E.2.d (Method SA-2)

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

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
Amplifier 26-40GHz	Miteq	NSP 4000 SP2	T1864	03/23/2020
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T1165	05/24/2020
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T931	05/11/2020
Amplifier, 1 to 18GHz, 35dB	Amplical	AFS42-00101800-25-S-42	T1567	01/26/2020
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T15	08/15/2019
Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T740	05/31/2020
Antenna Horn 26-40GHz	MITEQ	TTA2640-35-HG	T90	09/11/2019
*Antenna Horn, 18 to 26GHz	ARA	MWH-1826	T447	06/16/2019
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T757	09/25/2019
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T712	02/08/2020
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T136	07/02/2020
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T863	05/30/2020
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T346	05/14/2020
Hybrid Antenna, 30-3GHz	SunAR rf Motion	JB3	PRE0181574	08/01/2019
*Power Meter, P-series single channel	Keysight	N1911A	T1268	06/25/2019
Power Sensor	Keysight	N1921A	T1228	07/10/2019
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	03/23/2020
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A	T1454	01/23/2020
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A	T905	01/24/2020
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T459	07/25/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T908	01/23/2020

AC Line Conducted				
EMI Test Receiver 9KHz-7GHz	Rohde & Schwarz	ESCI7	T1436	02/14/2020
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2019
*LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/19/2019
UL AUTOMATION SOFTWARE				
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016	
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016	
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015	

*Testing is completed before equipment expiration date.

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

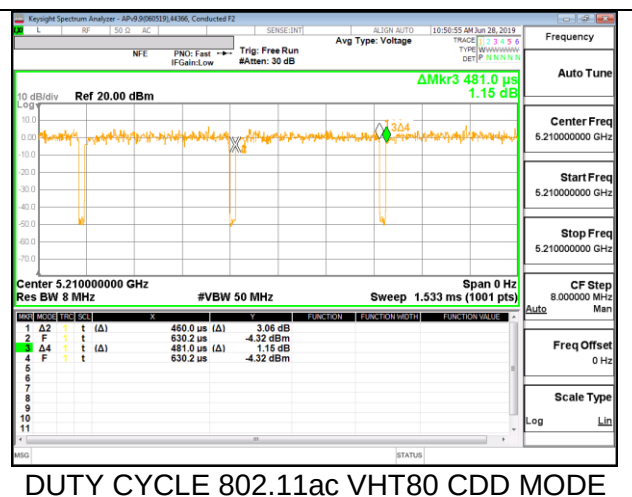
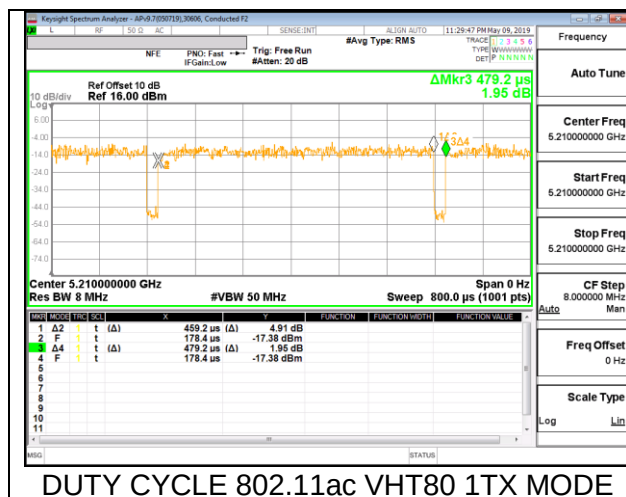
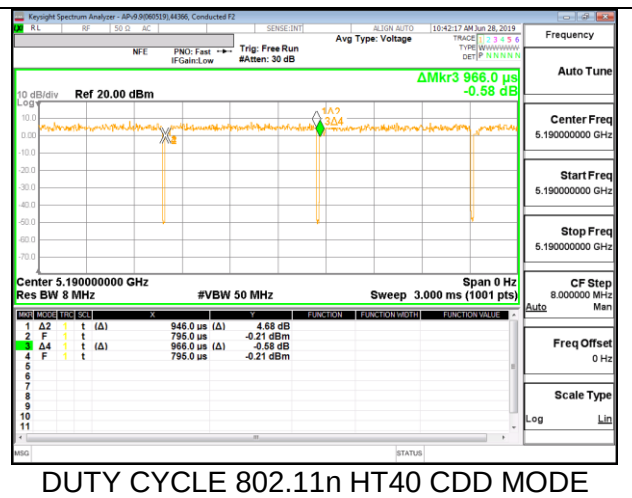
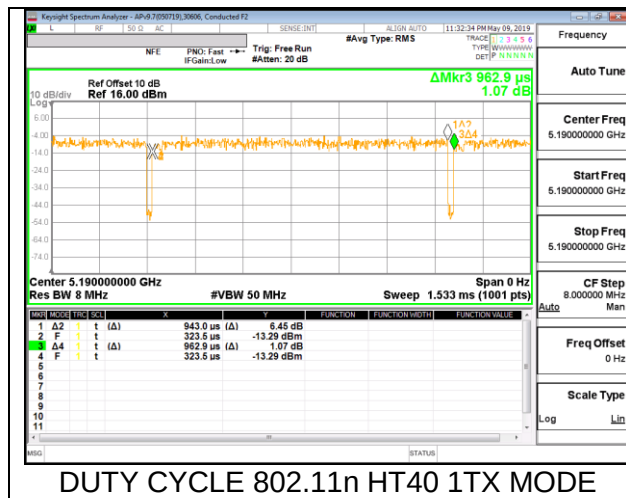
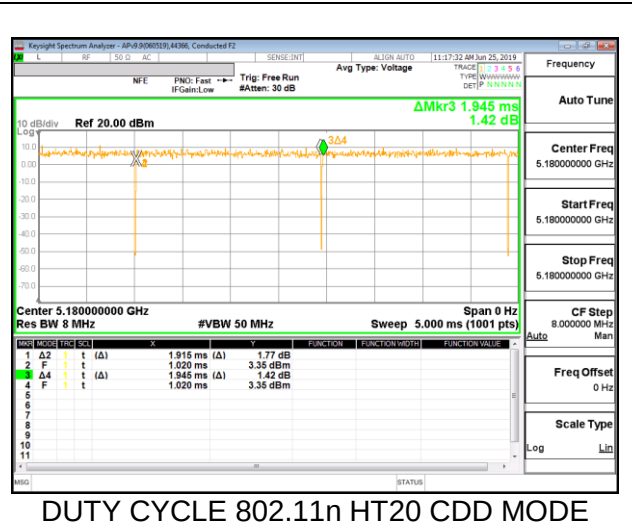
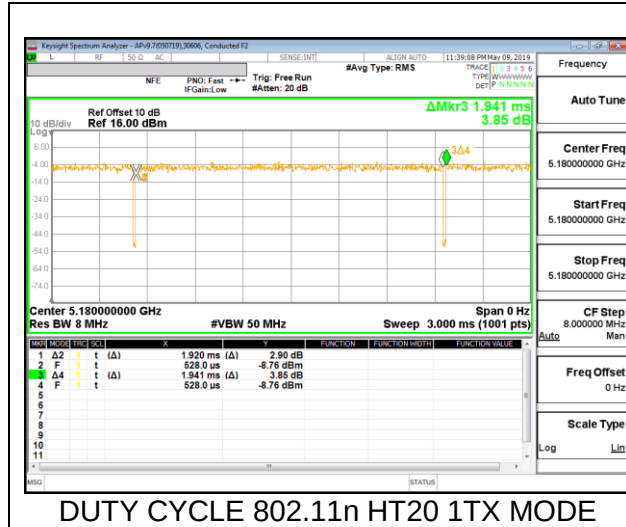
None; for reporting purposes only.

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)
5GHz Band						
802.11n HT20 1Tx	1.920	1.941	0.989	98.92%	0.00	0.010
802.11n HT20 CDD	1.915	1.945	0.985	98.46%	0.00	0.010
802.11n HT40 1Tx	0.943	0.963	0.979	97.92%	0.09	1.060
802.11n HT40 CDD	0.946	0.966	0.979	97.93%	0.09	1.057
802.11ac VHT80 1Tx	0.459	0.479	0.958	95.82%	0.19	2.179
802.11ac VHT80 CDD	0.460	0.481	0.956	95.63%	0.19	2.174
802.11ax HE20 1Tx, 242-Tones	3.055	3.075	0.993	99.35%	0.00	0.010
802.11ax HE20 1Tx, 26-Tones	4.120	4.155	0.992	99.16%	0.00	0.010
802.11ax HE20 OFDMA, 242-Tones	3.060	3.080	0.994	99.35%	0.00	0.010
802.11ax HE20 OFDMA, 26-Tones	4.120	4.155	0.992	99.16%	0.00	0.010
802.11ax HE40 1Tx, 484-Tones	1.560	1.580	0.987	98.73%	0.00	0.010
802.11ax HE40 1Tx, 26-Tones	4.120	4.155	0.992	99.16%	0.00	0.010
802.11ax HE40 OFDMA, 484-Tones	1.560	1.580	0.987	98.73%	0.00	0.010
802.11ax HE40 OFDMA, 26-Tones	4.120	4.155	0.992	99.16%	0.00	0.010
802.11ax HE80 1Tx, 996-Tones	1.476	1.494	0.988	98.80%	0.00	0.010
802.11ax HE80 1Tx, 26-Tones	4.120	4.155	0.992	99.16%	0.00	0.010
802.11ax HE80 OFDMA, 996-Tones	1.473	1.494	0.986	98.59%	0.00	0.010
802.11ax HE80 OFDMA, 26-Tones	4.125	4.155	0.993	99.28%	0.00	0.010









8.2. 26 dB BANDWIDTH

LIMITS

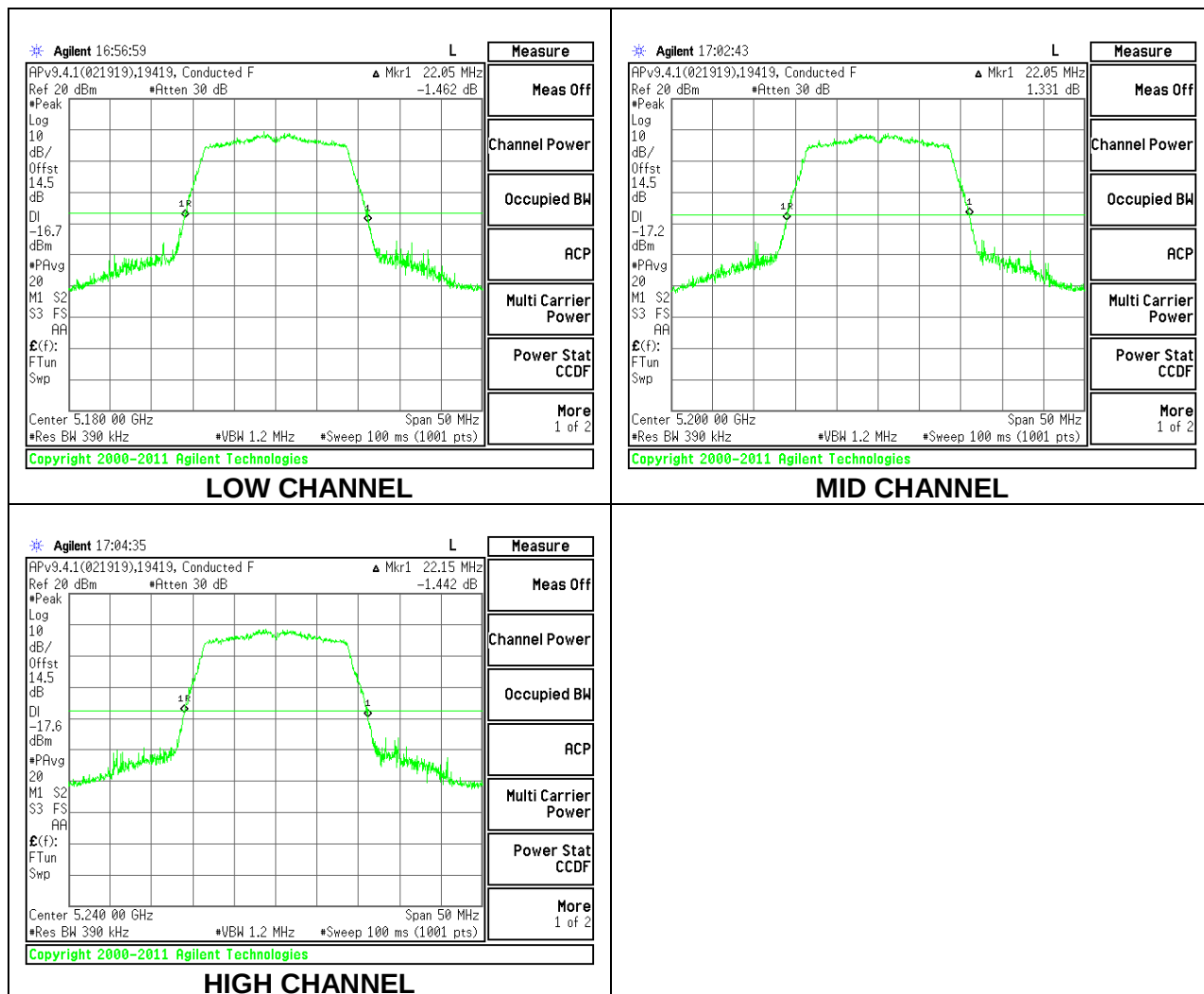
None; for reporting purposes only.

RESULTS

8.2.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND

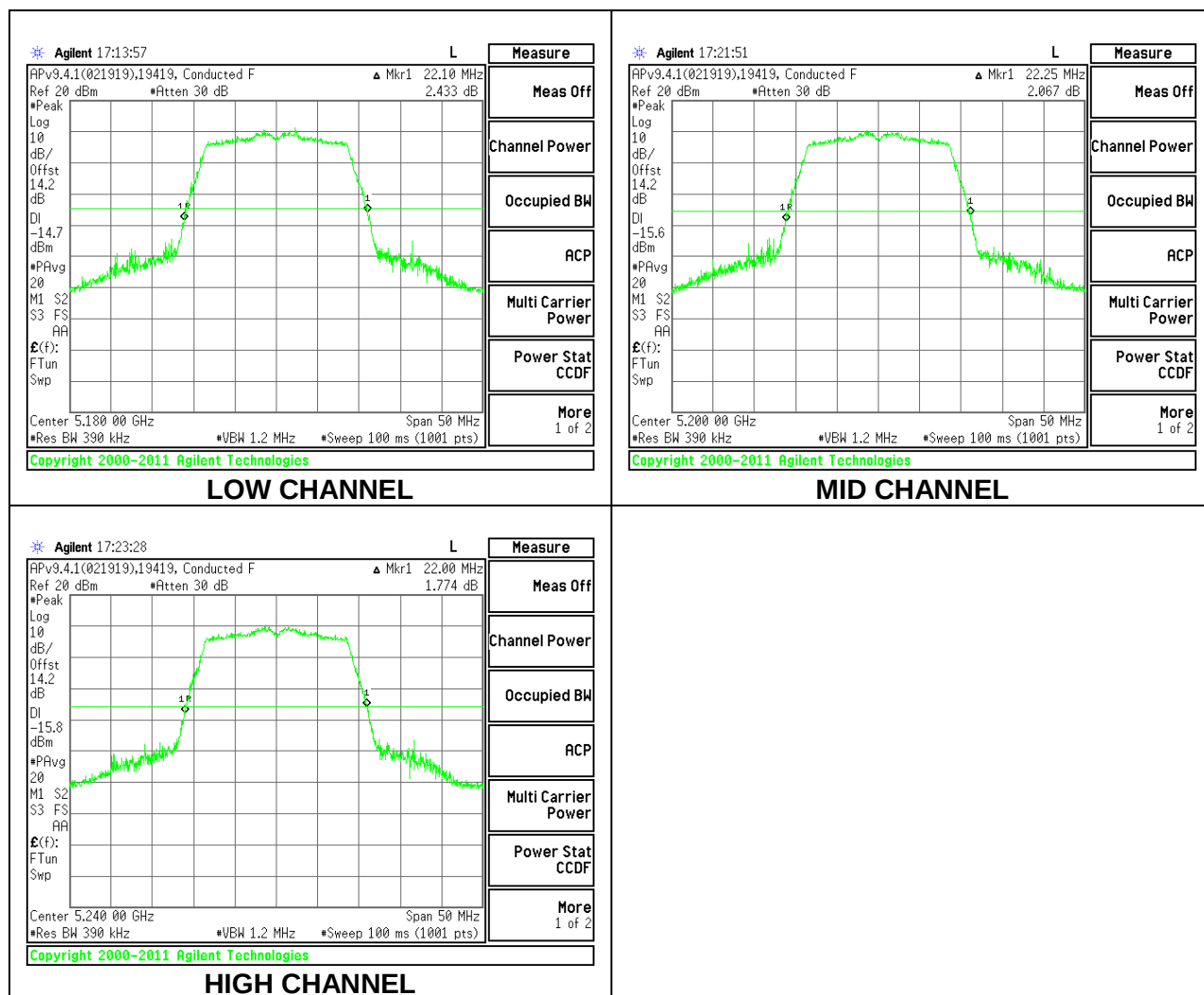
1TX Antenna 4 MODE

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Low	5180	22.05
Mid	5200	22.05
High	5240	22.15



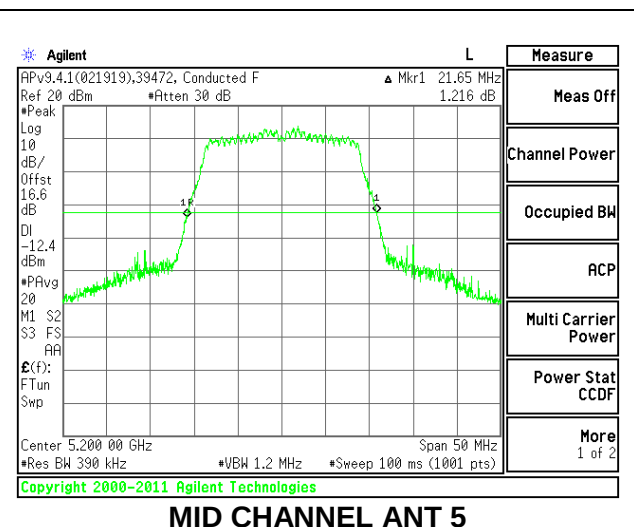
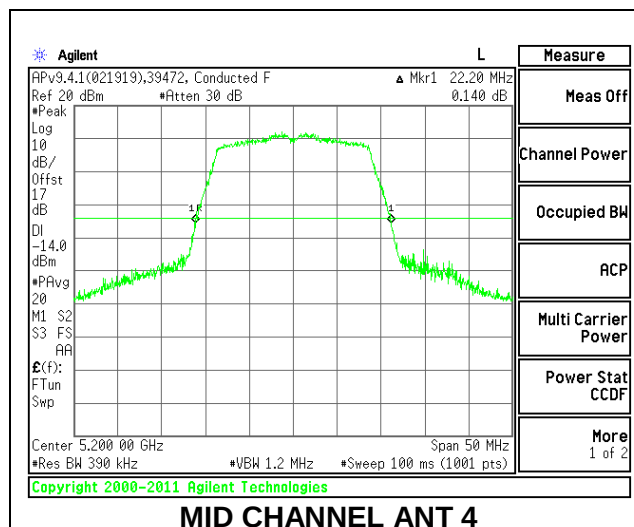
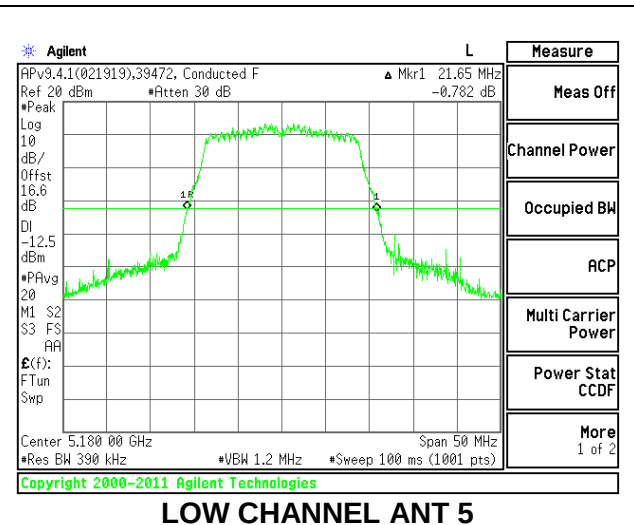
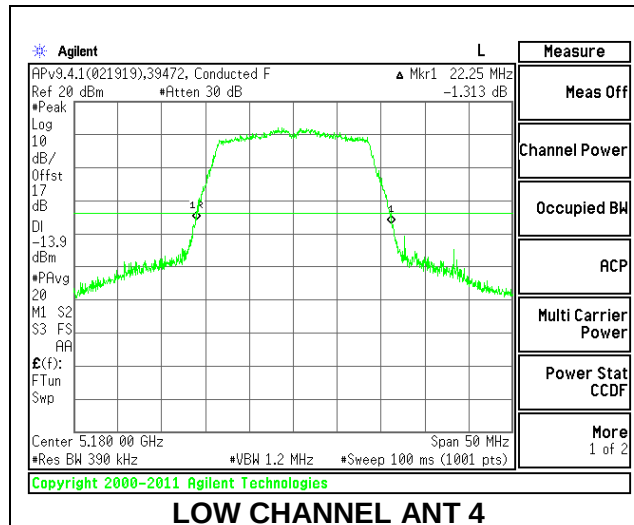
1TX Antenna 5 MODE

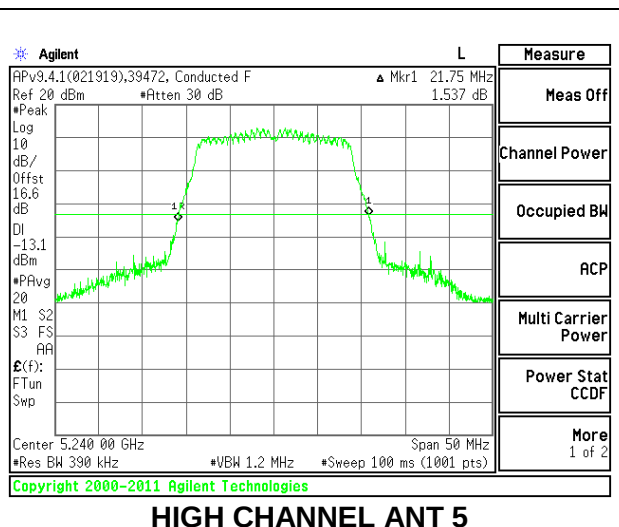
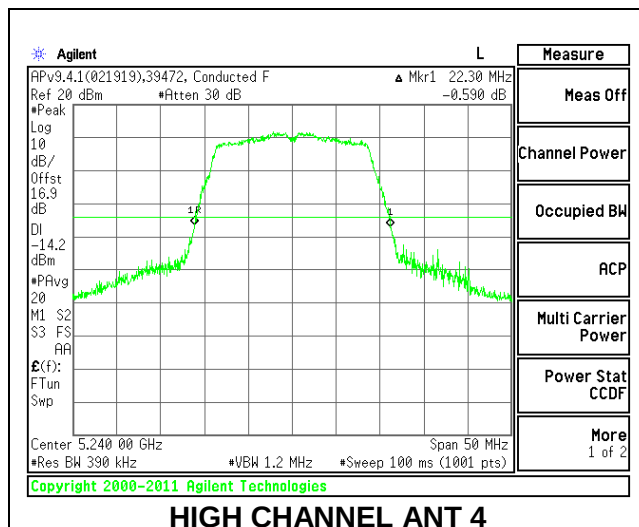
Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Low	5180	22.10
Mid	5200	22.25
High	5240	22.00



2TX Antenna 4 + Antenna 5 CDD MODE

Channel	Frequency	26 dB Bandwidth	26 dB Bandwidth
	(MHz)	Ant 4	Ant 5
Low	5180	22.25	21.65
Mid	5200	22.20	21.65
High	5240	22.30	21.75

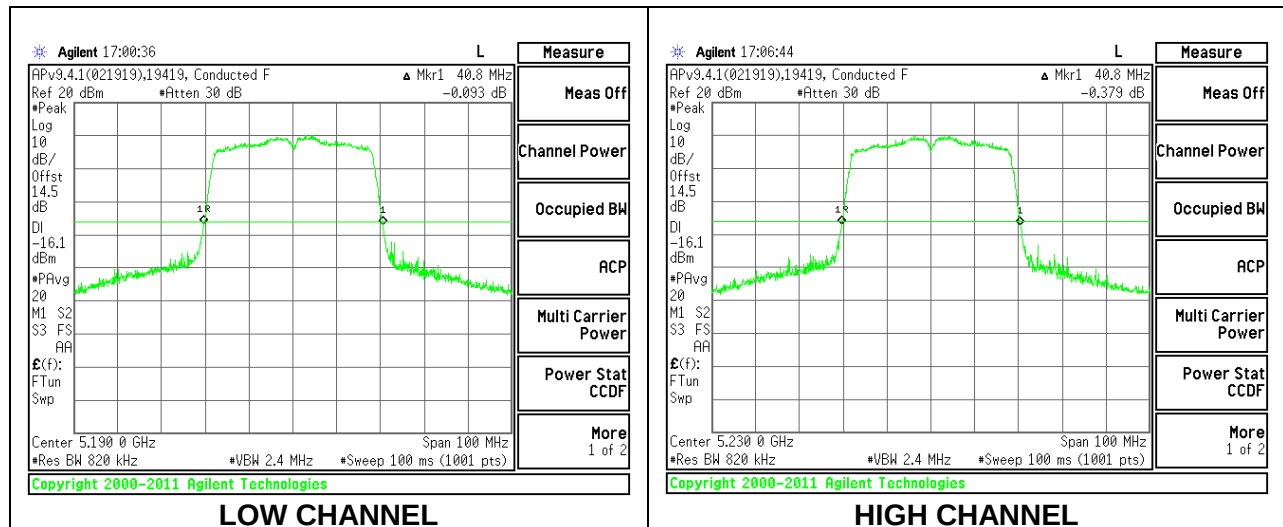




8.2.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND

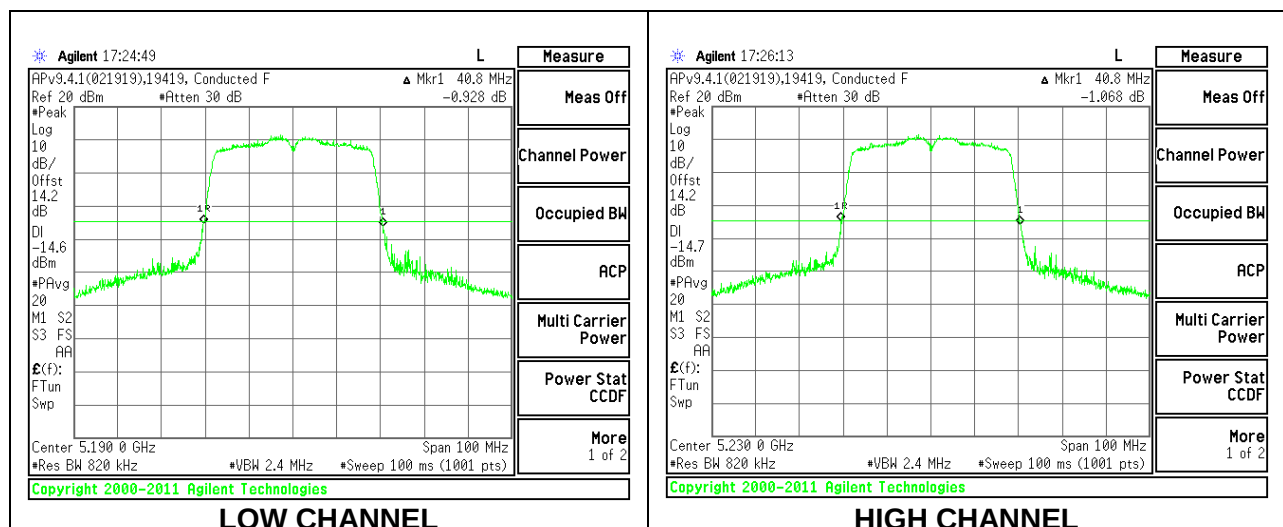
1TX Antenna 4 MODE

Channel	Frequency	26dB Bandwidth
	(MHz)	(MHz)
Low	5190	40.80
High	5230	40.80



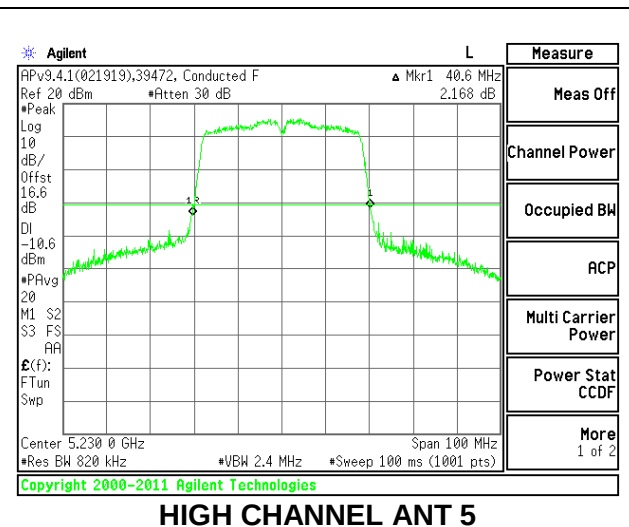
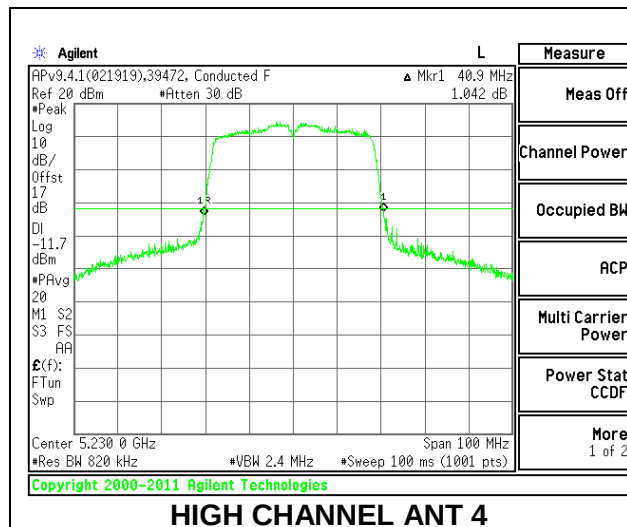
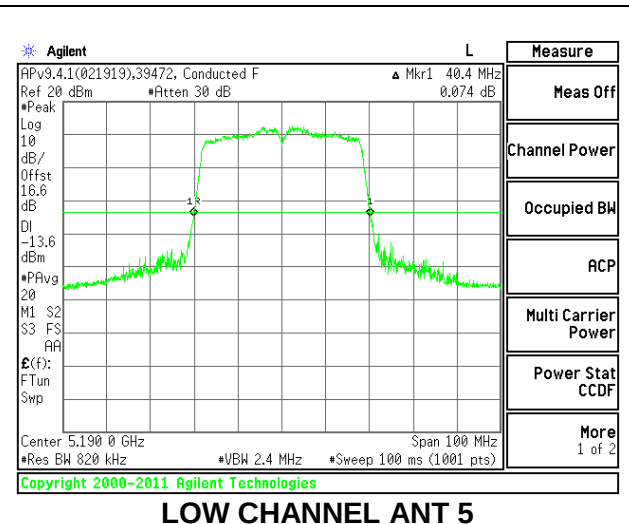
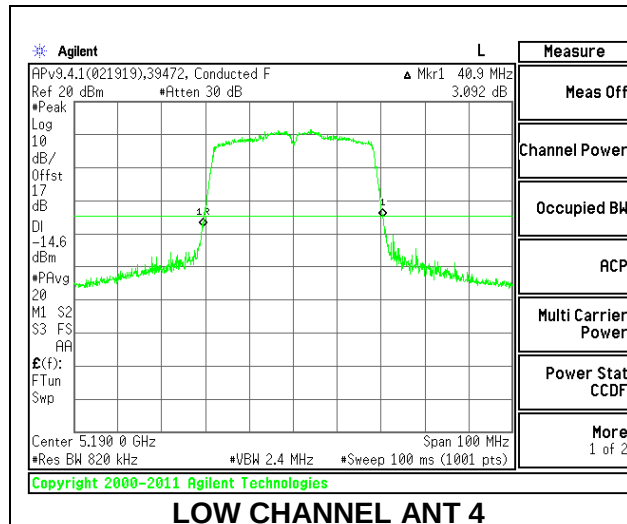
1TX Antenna 5 MODE

Channel	Frequency	26dB Bandwidth
	(MHz)	(MHz)
Low	5190	40.80
High	5230	40.80



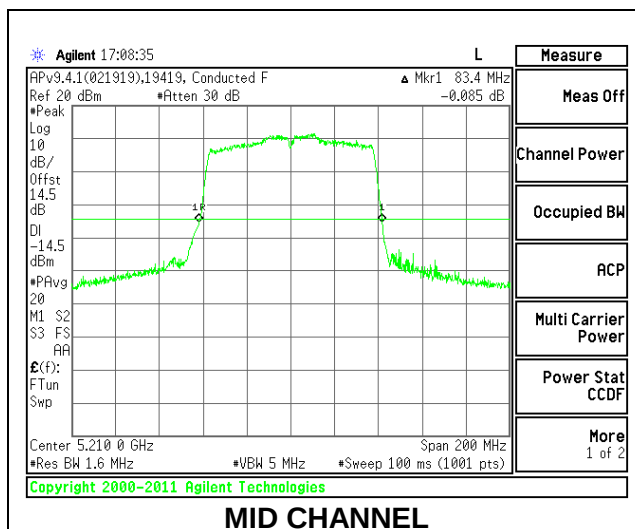
2TX Antenna 4 + Antenna 5 CDD MODE

Channel	Frequency	26 dB Bandwidth	26 dB Bandwidth
	(MHz)	Ant 4 (MHz)	Ant 5 (MHz)
Low	5190	40.90	40.40
High	5230	40.90	40.60

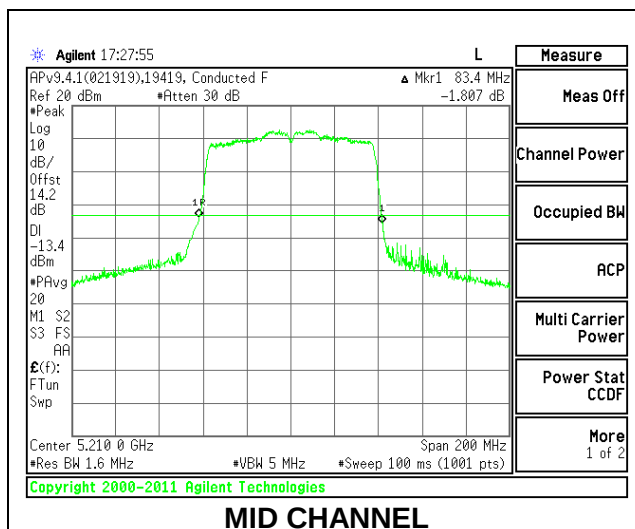


8.2.3. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND**1TX Antenna 4 MODE**

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Mid	5210	83.40

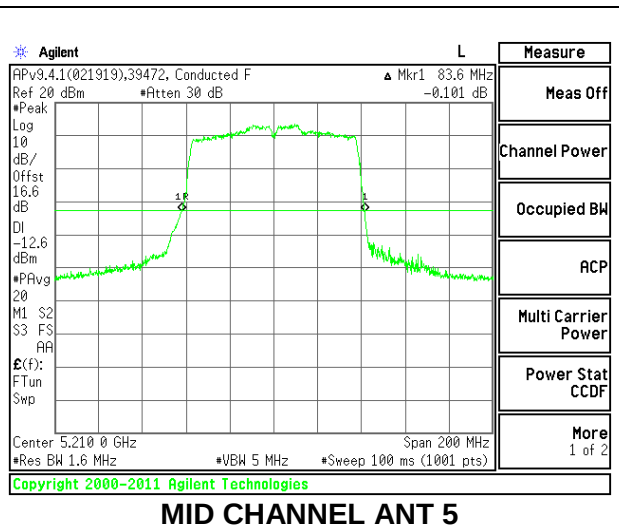
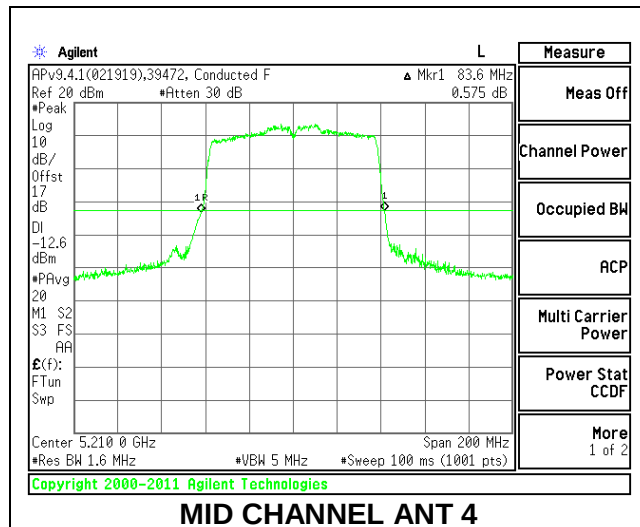
**1TX Antenna 5 MODE**

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Mid	5210	83.40



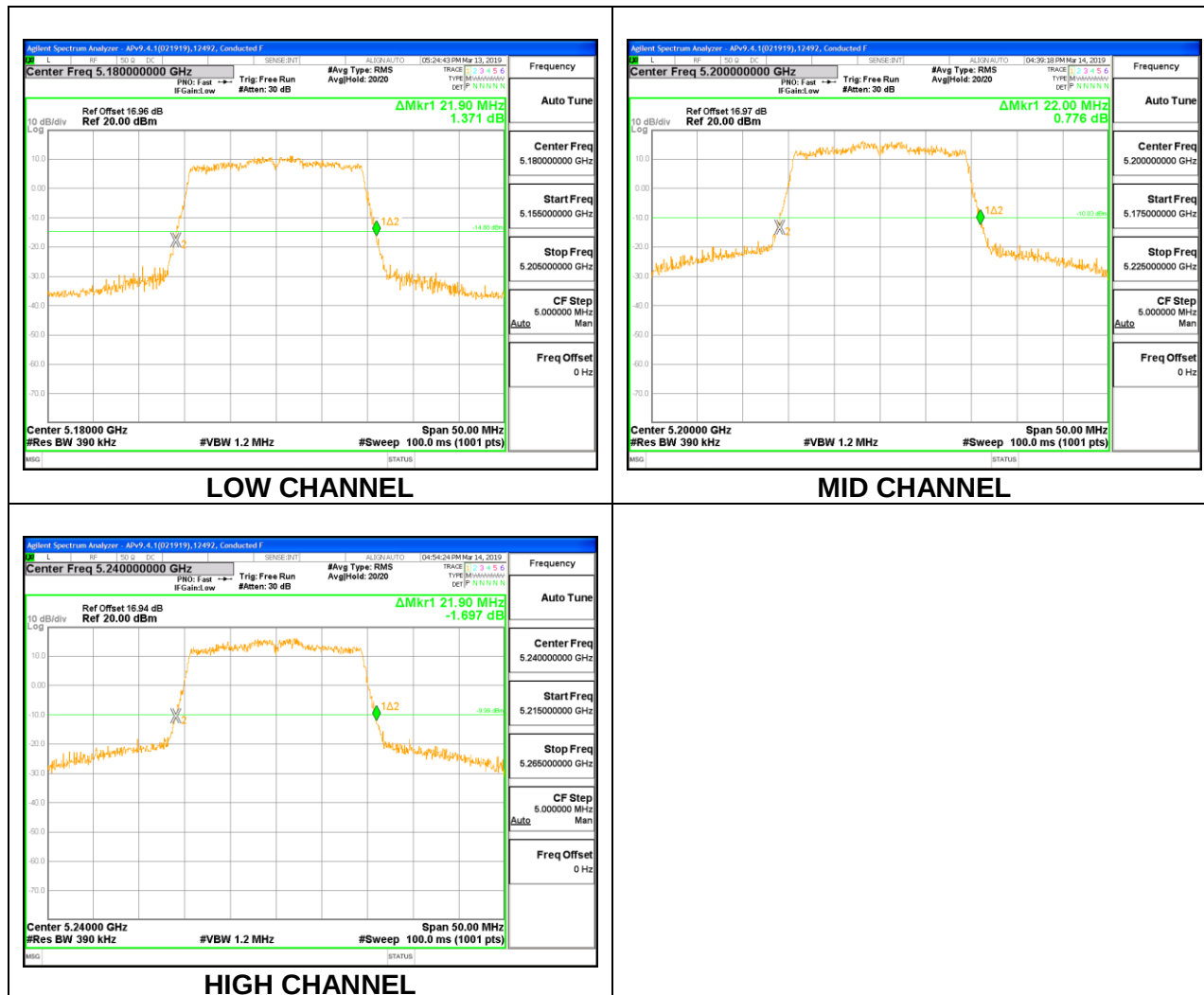
2TX Antenna 4 + Antenna 5 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Ant 4 (MHz)	26 dB Bandwidth Ant 5 (MHz)
Mid	5210	83.60	83.60



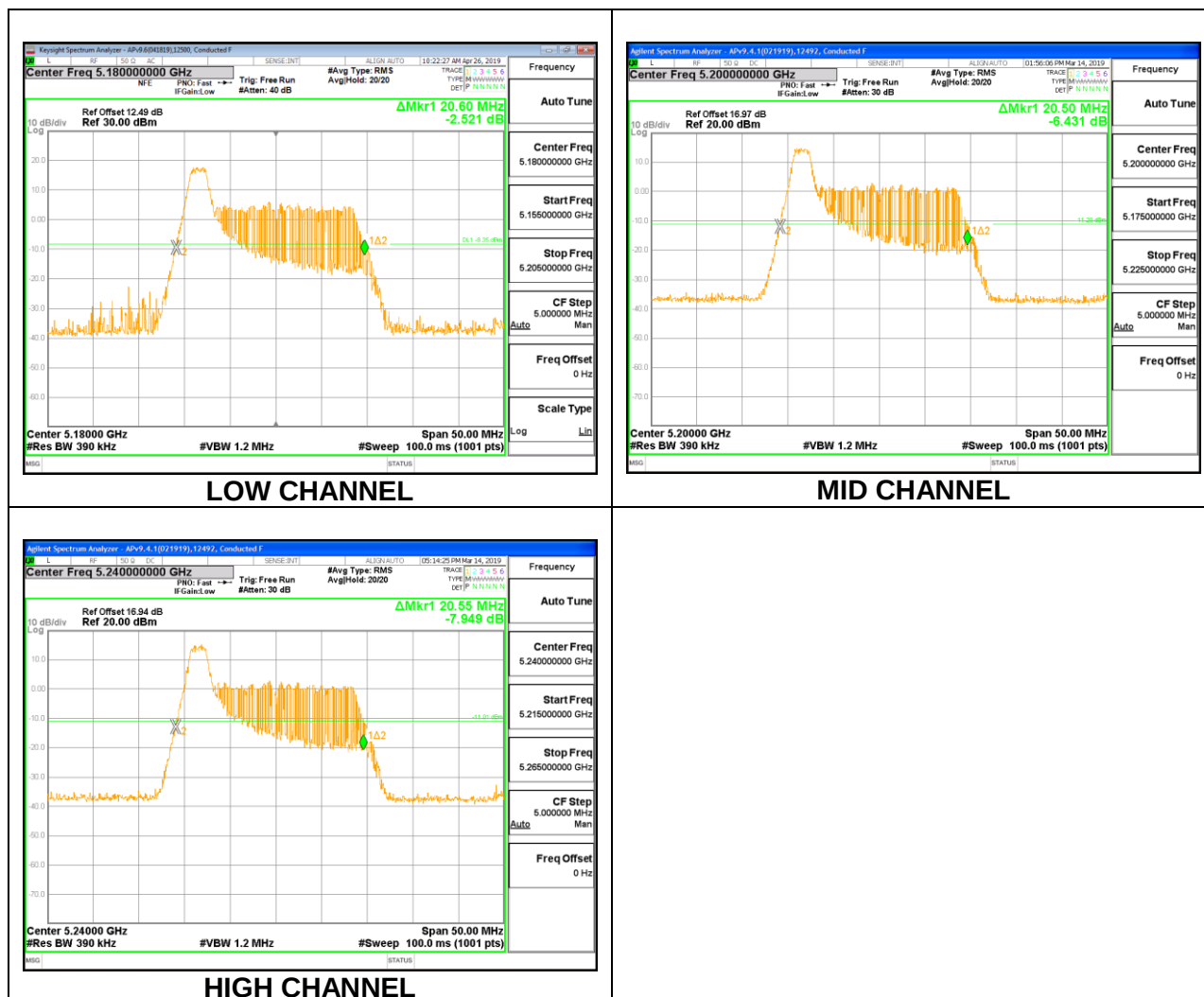
8.2.4. 802.11ax HE20 MODE IN THE 5.2 GHz BAND**1TX Antenna 4 MODE – 242-Tones, RU Index 61**

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Low	5180	21.90
Mid	5200	22.00
High	5240	21.90



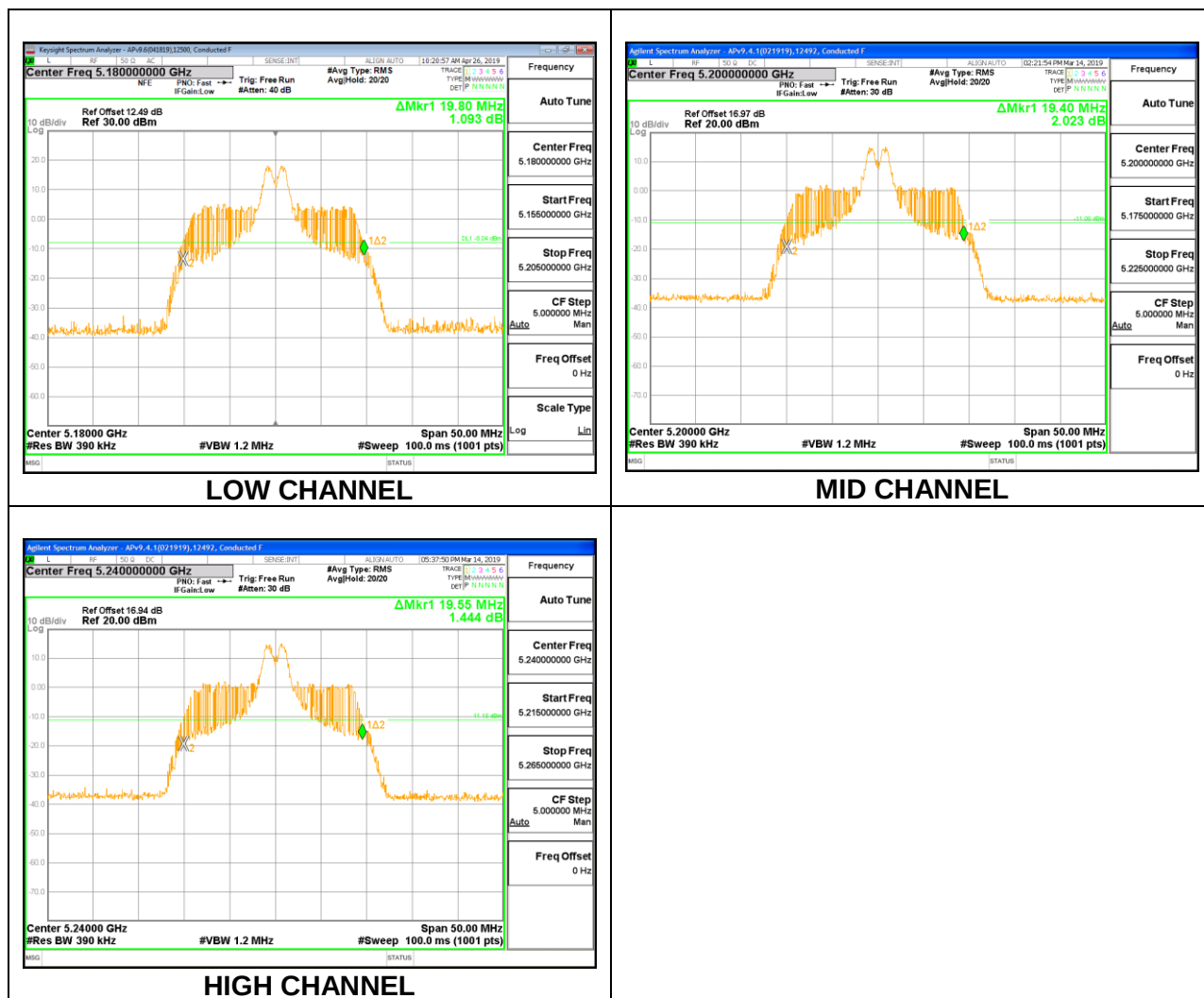
1TX Antenna 4 MODE – 26-Tones, RU Index 0

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	20.60
Mid	5200	20.50
High	5240	20.55



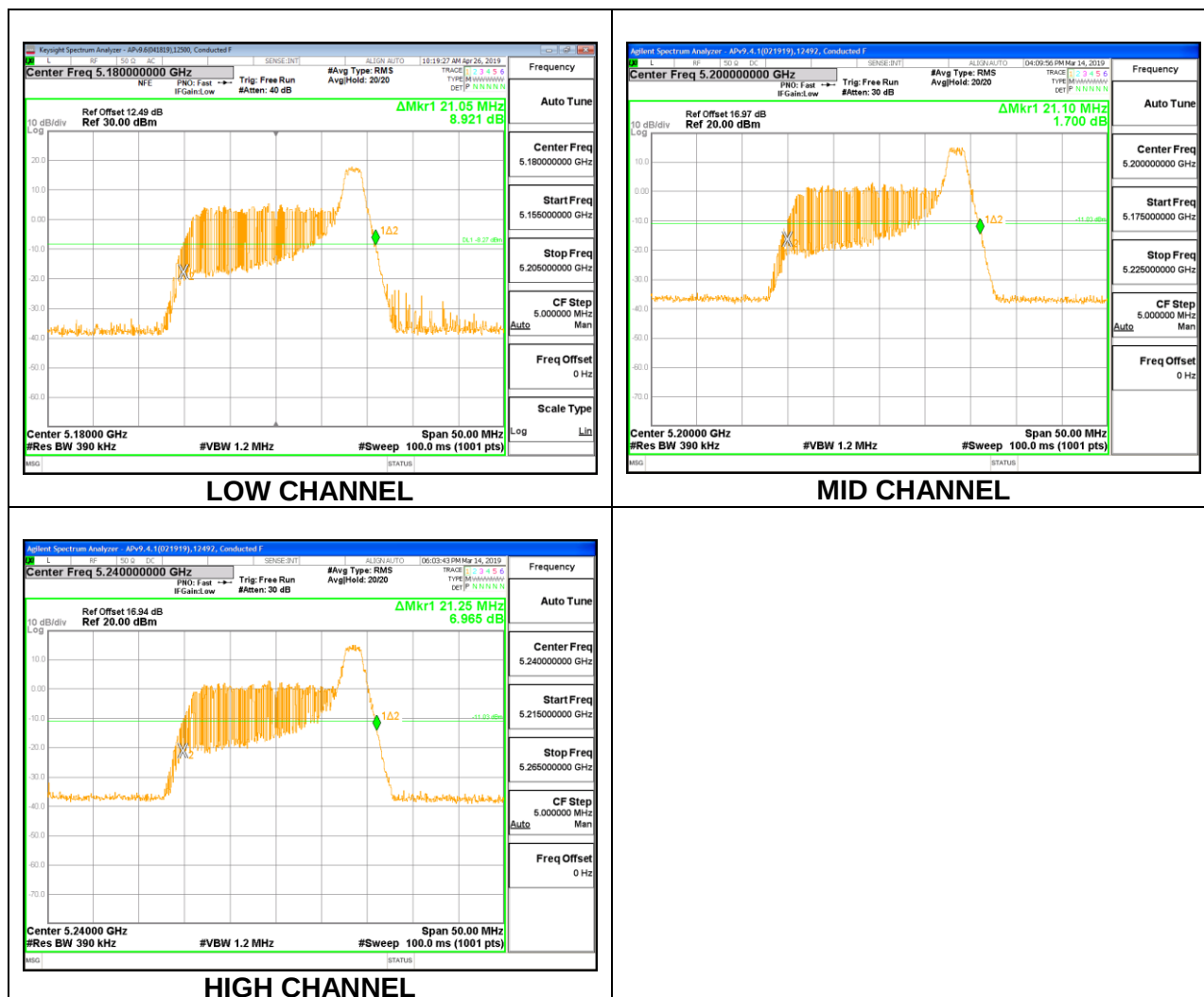
1TX Antenna 4 MODE – 26-Tones, RU Index 4

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	19.80
Mid	5200	19.40
High	5240	19.55



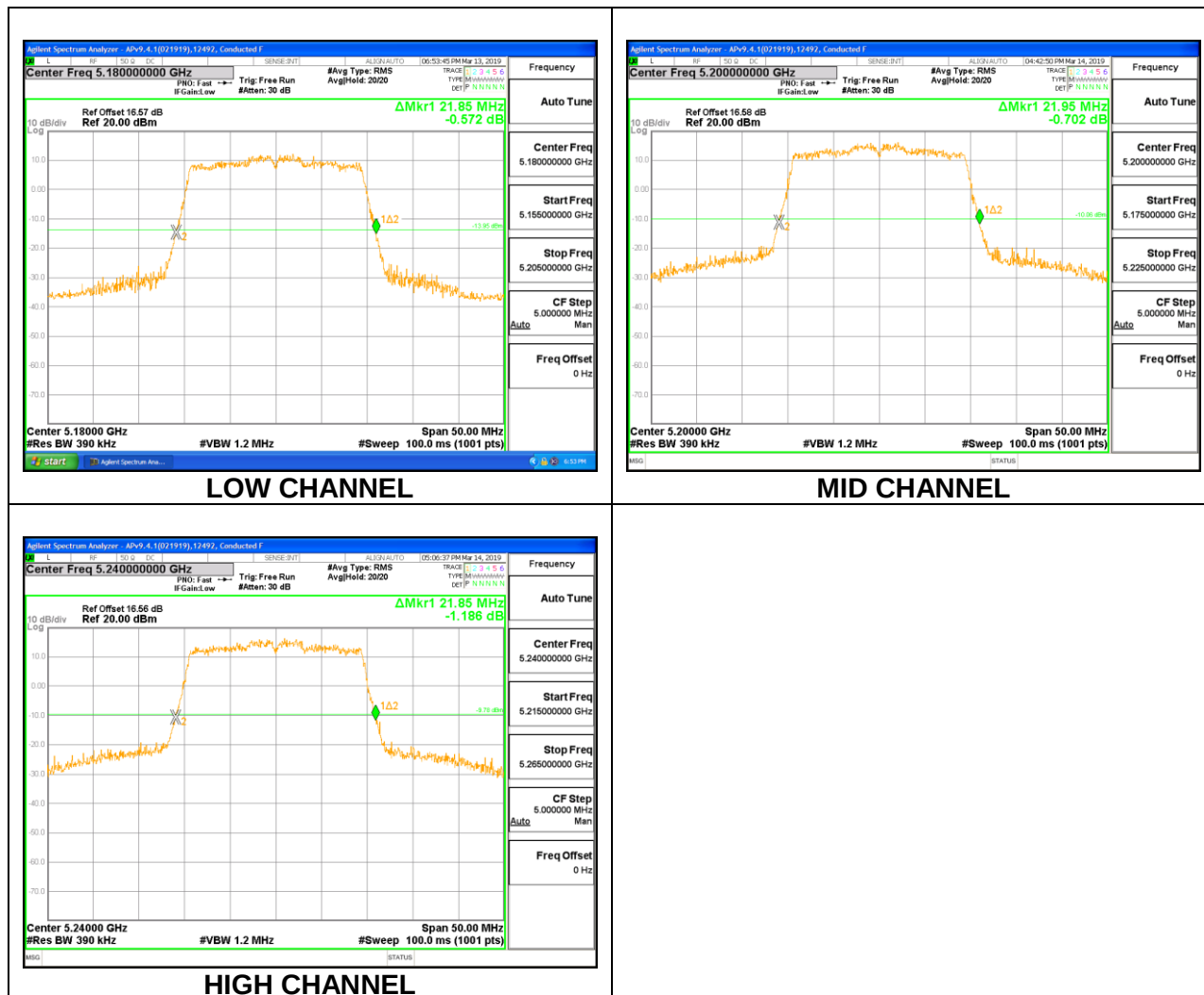
1TX Antenna 4 MODE – 26-Tones, RU Index 8

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	21.05
Mid	5200	21.10
High	5240	21.25



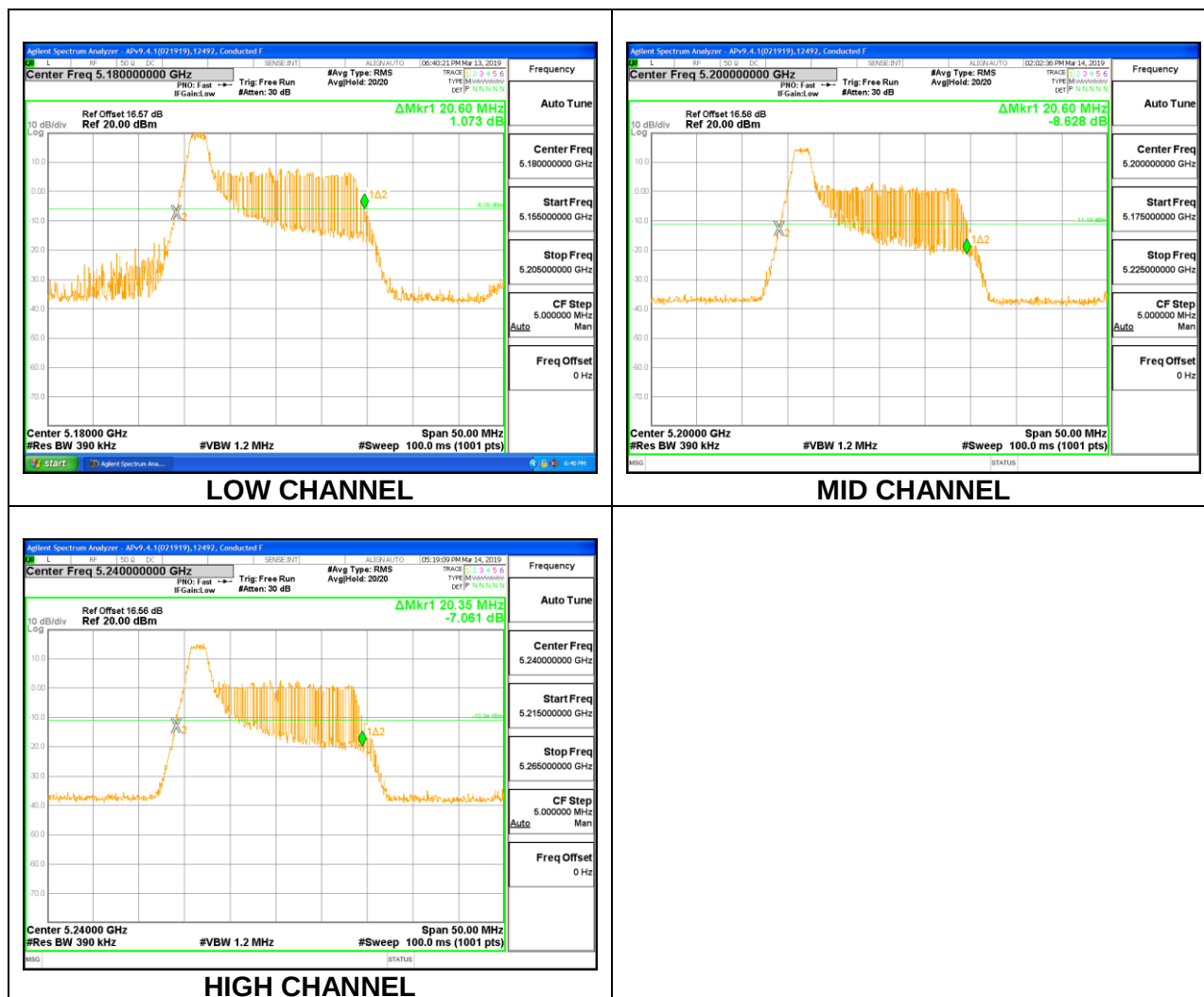
1TX Antenna 5 MODE – 242-Tones, RU Index 61

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	21.85
Mid	5200	21.95
High	5240	21.85



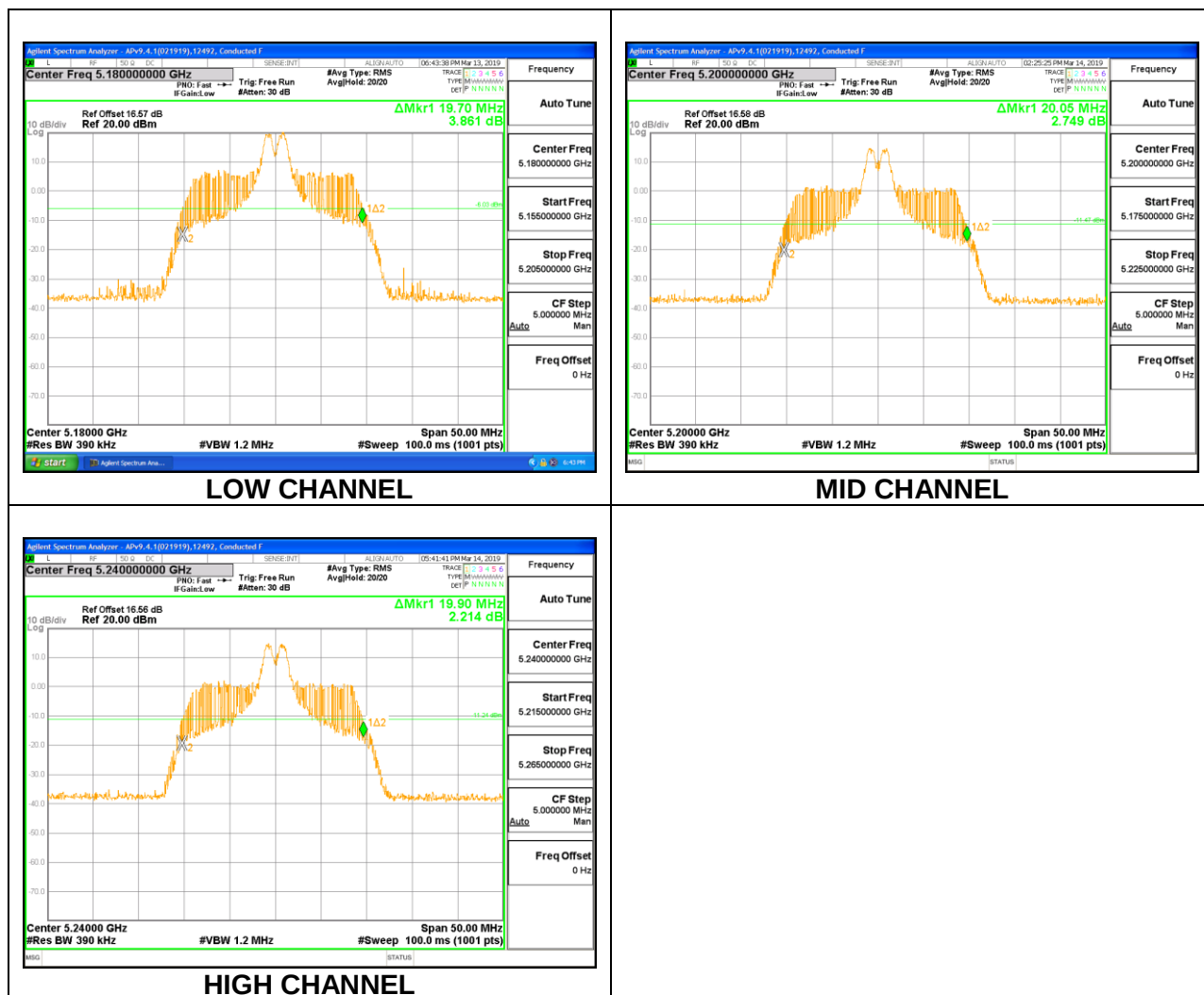
1TX Antenna 5 MODE – 26-Tones, RU Index 0

Channel	Frequency	26 dB Bandwidth
	(MHz)	(MHz)
Low	5180	20.60
Mid	5200	20.60
High	5240	20.35



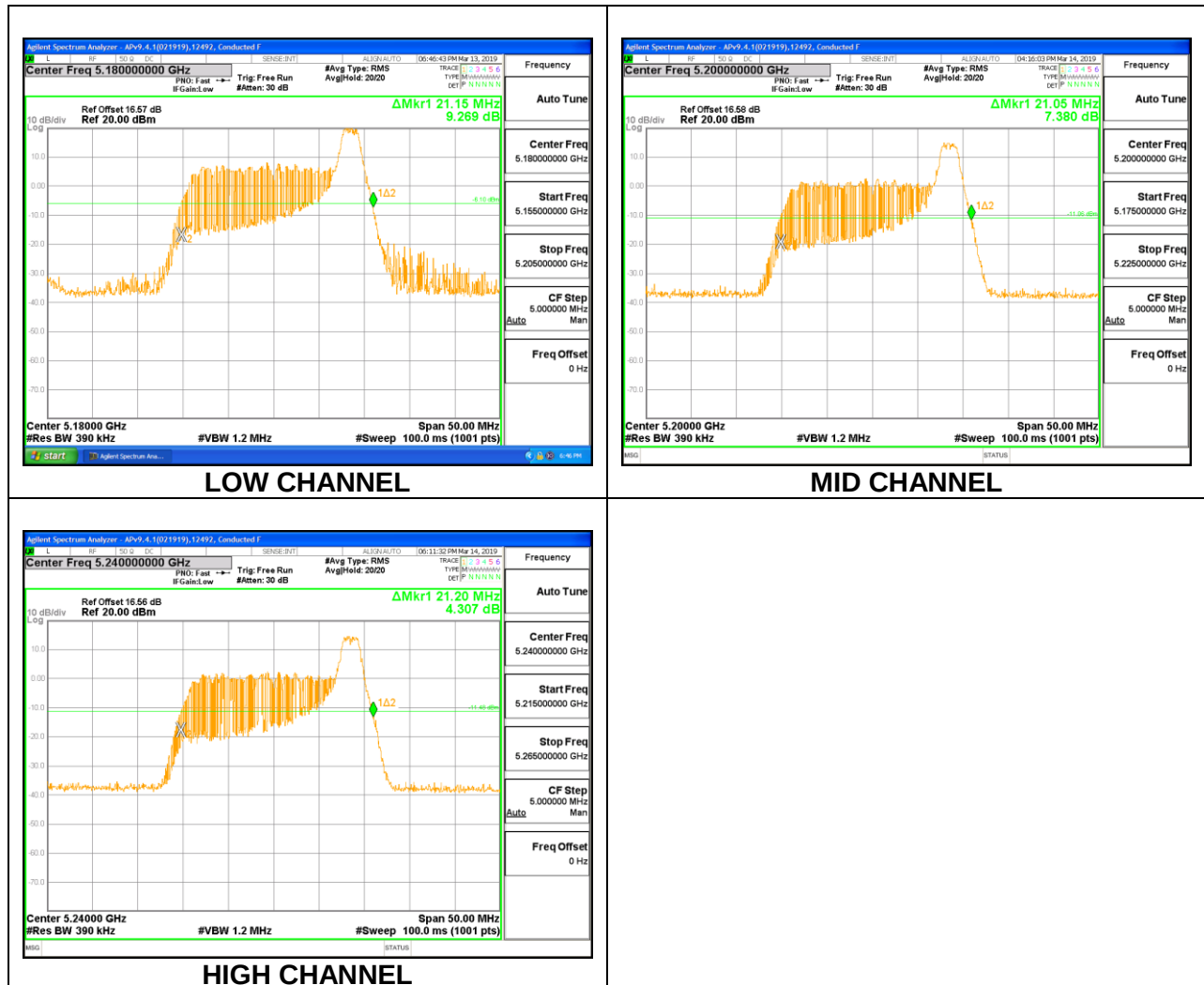
1TX Antenna 5 MODE – 26-Tones, RU Index 4

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	19.70
Mid	5200	20.05
High	5240	19.90



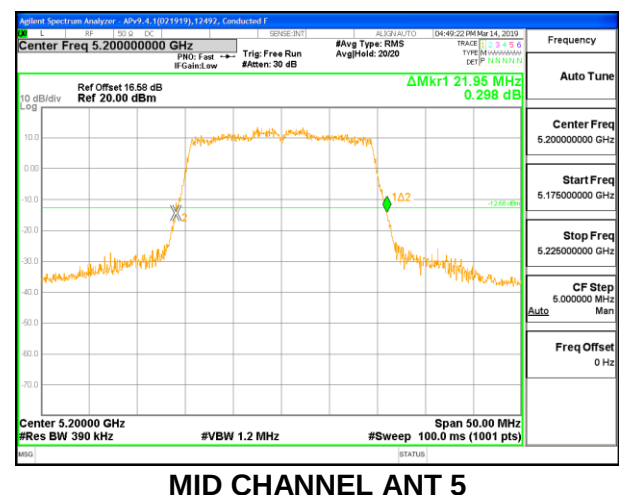
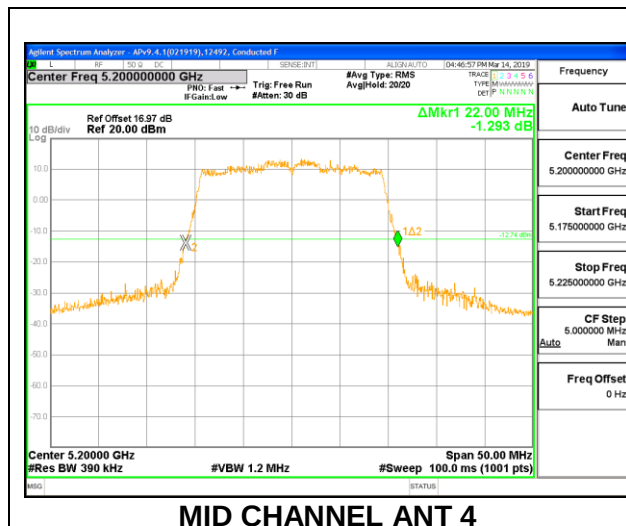
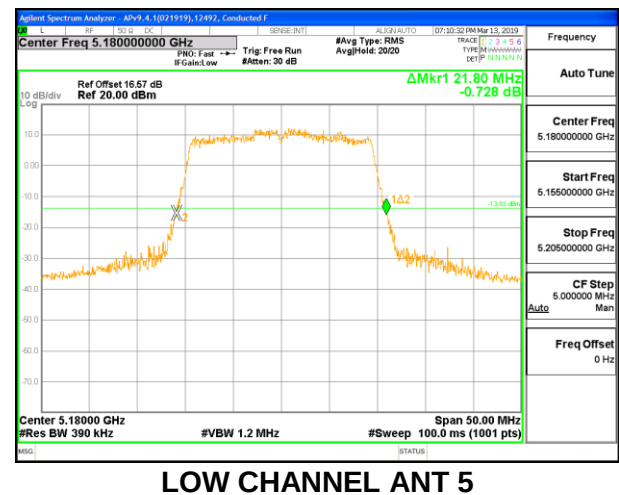
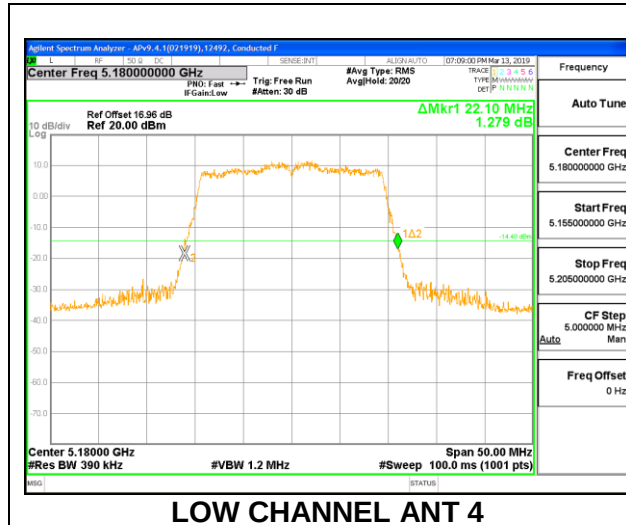
1TX Antenna 5 MODE – 26-Tones, RU Index 8

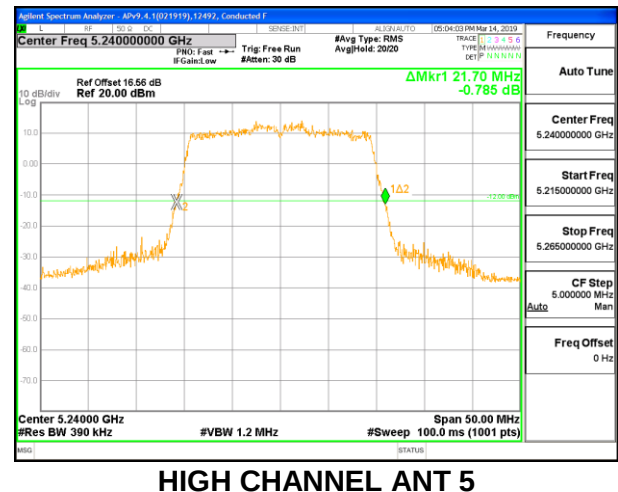
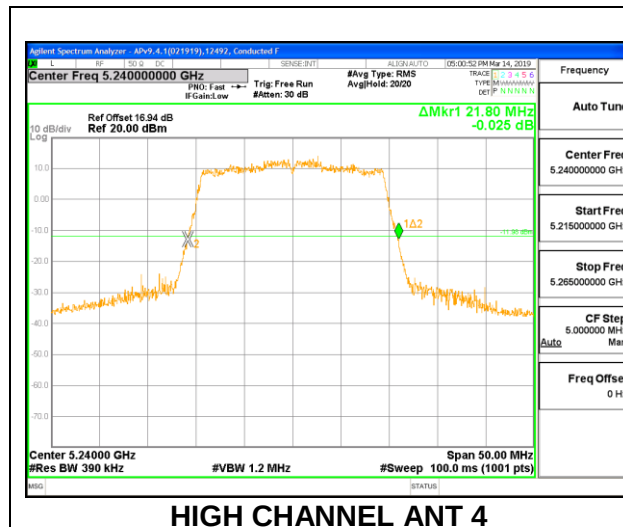
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	21.15
Mid	5200	21.05
High	5240	21.20



2TX Antenna 4 + Antenna 5 OFDMA MODE – 242 Tones, RU Index 61

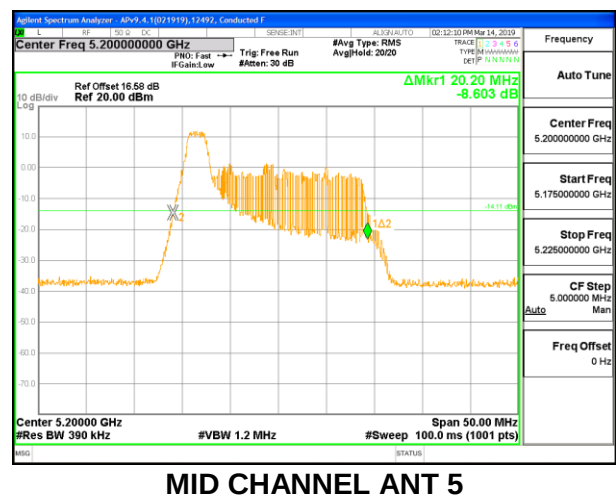
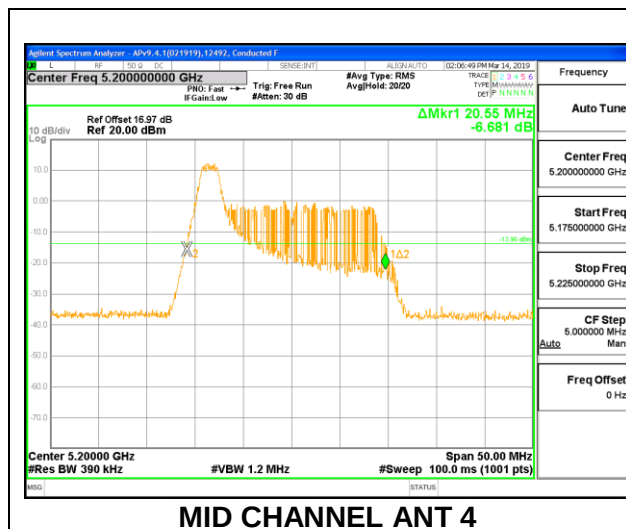
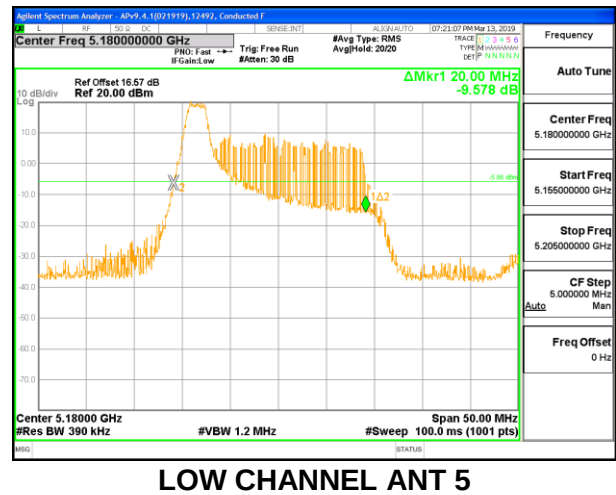
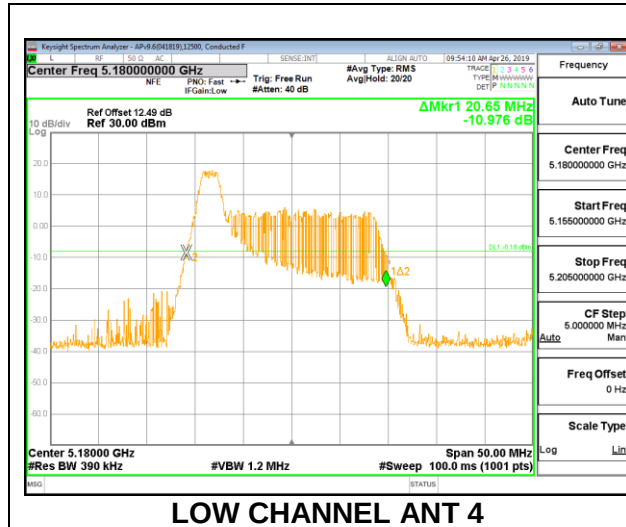
Channel	Frequency (MHz)	26 dB Bandwidth Ant 4 (MHz)	26 dB Bandwidth Ant 5 (MHz)
Low	5180	22.10	21.80
Mid	5200	22.00	21.95
High	5240	21.80	21.70

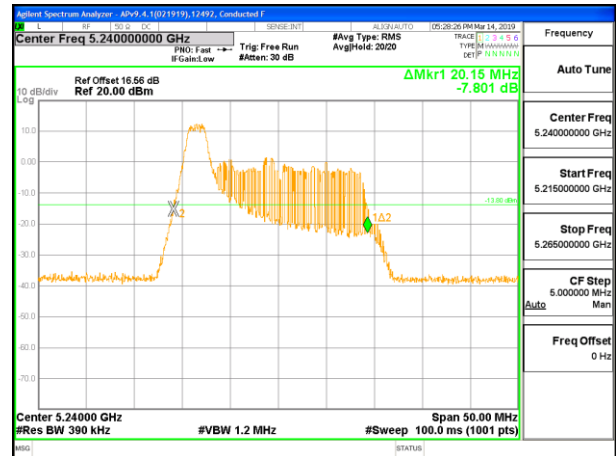
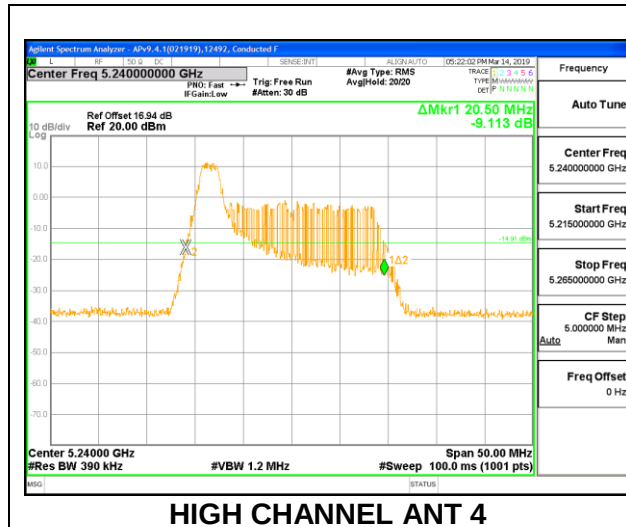




2TX Antenna 4 + Antenna 5 OFDMA MODE – 26 Tones, RU Index 0

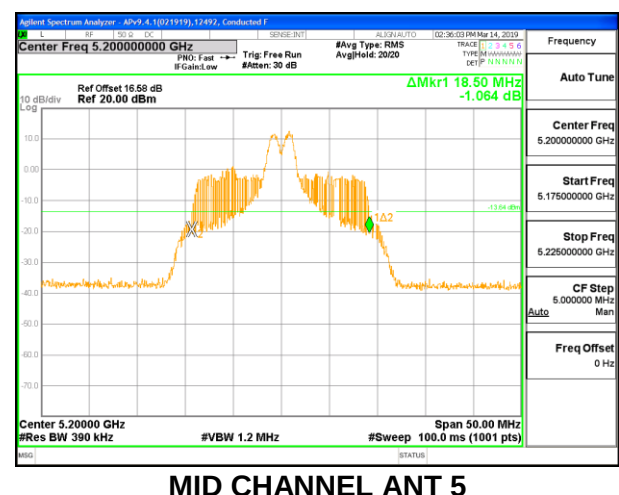
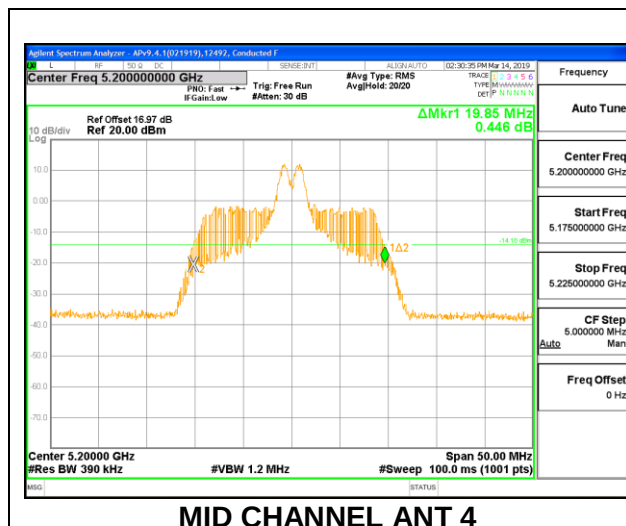
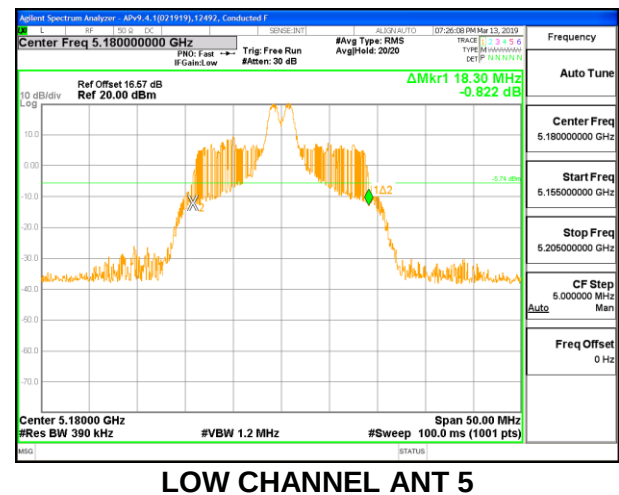
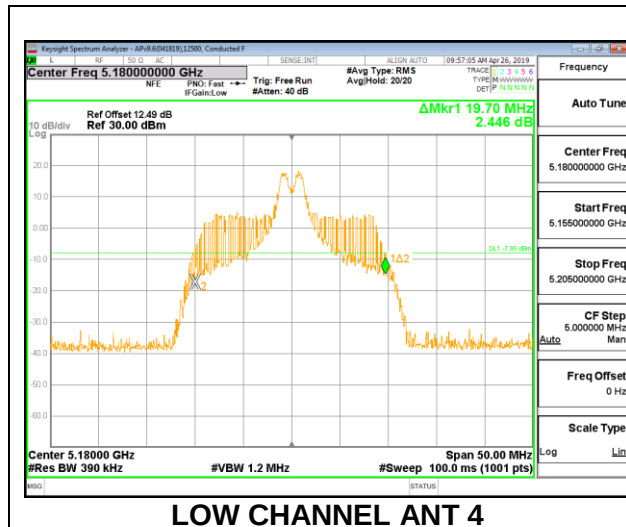
Channel	Frequency	26 dB Bandwidth	26 dB Bandwidth
	(MHz)	Ant 4 (MHz)	Ant 5 (MHz)
Low	5180	20.65	20.00
Mid	5200	20.55	20.20
High	5240	20.50	20.15

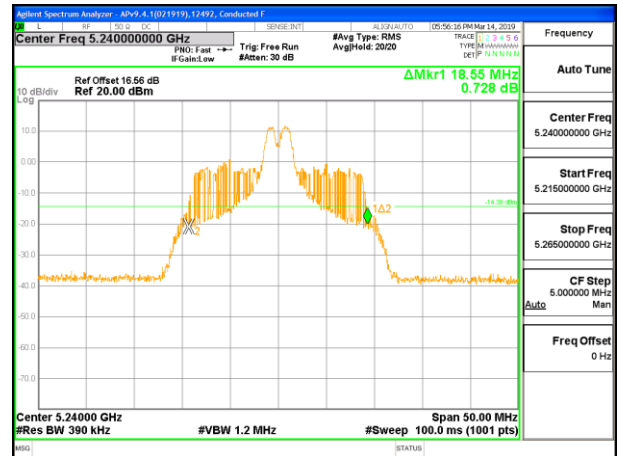
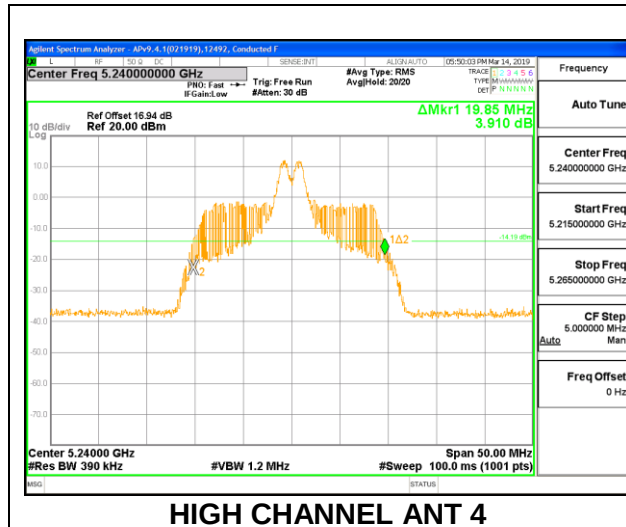




2TX Antenna 4 + Antenna 5 OFDMA MODE – 26 Tones, RU Index 4

Channel	Frequency	26 dB Bandwidth	26 dB Bandwidth
	(MHz)	Ant 4 (MHz)	Ant 5 (MHz)
Low	5180	19.70	18.30
Mid	5200	19.85	18.50
High	5240	19.85	18.55

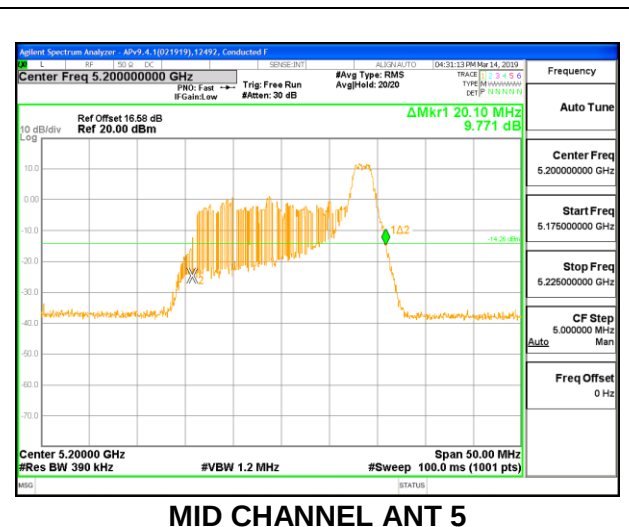
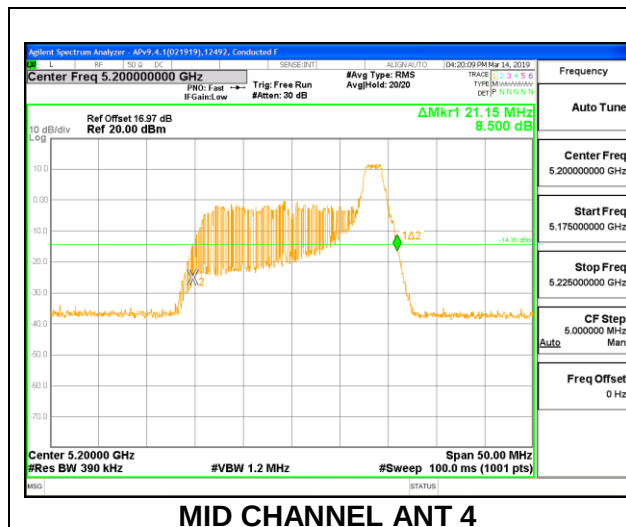
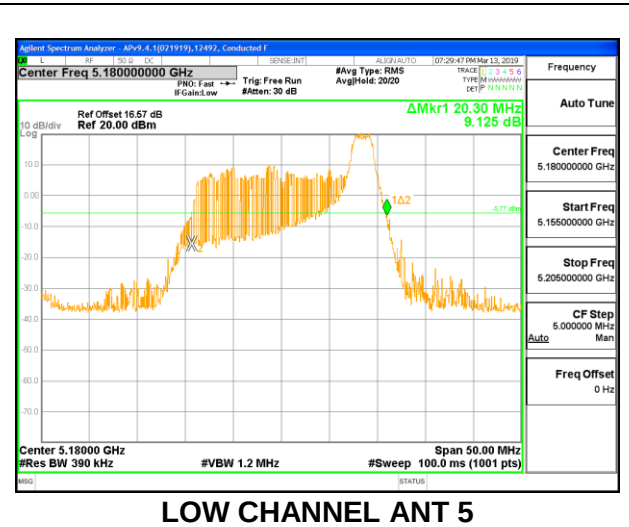
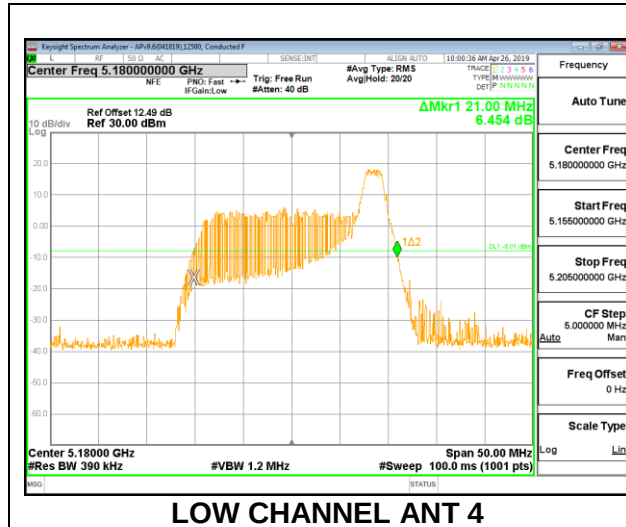


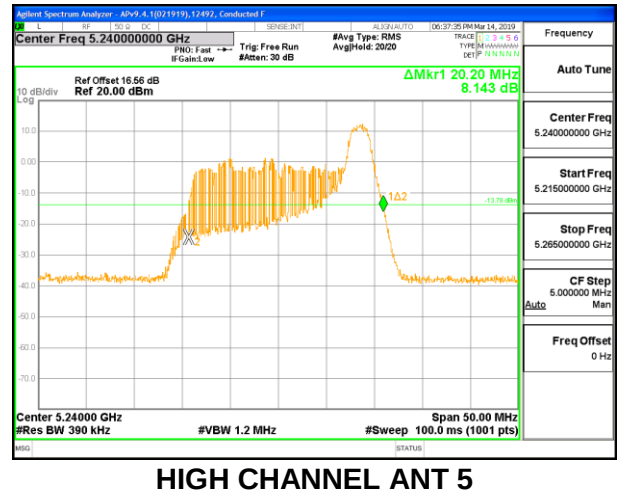
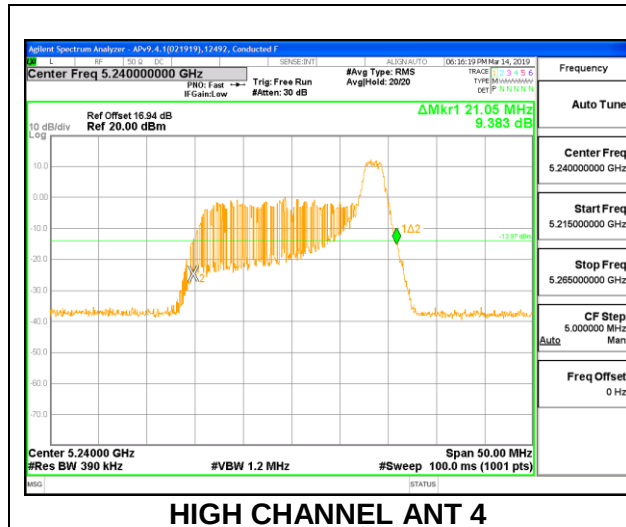


HIGH CHANNEL ANT 5

2TX Antenna 4 + Antenna 5 OFDMA MODE – 26 Tones, RU Index 8

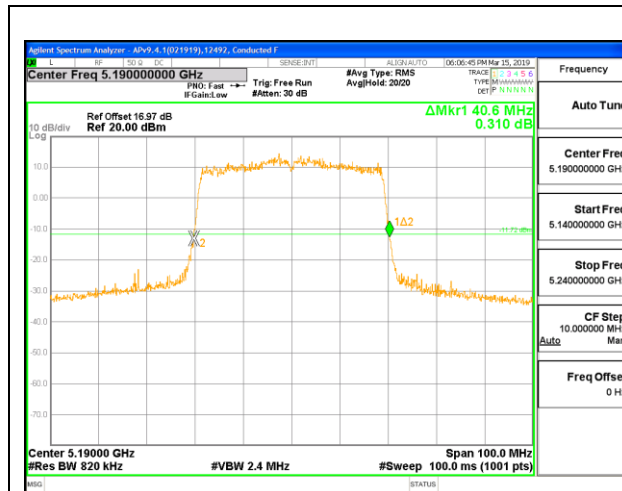
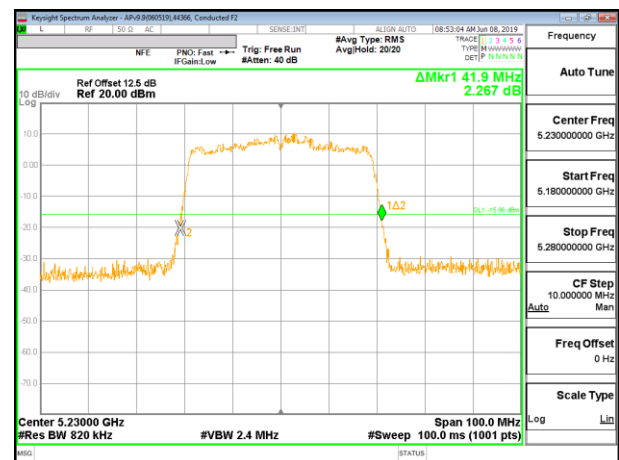
Channel	Frequency (MHz)	26 dB Bandwidth	
		Ant 4 (MHz)	Ant 5 (MHz)
Low	5180	21.00	20.30
Mid	5200	21.15	20.10
High	5240	21.05	20.20



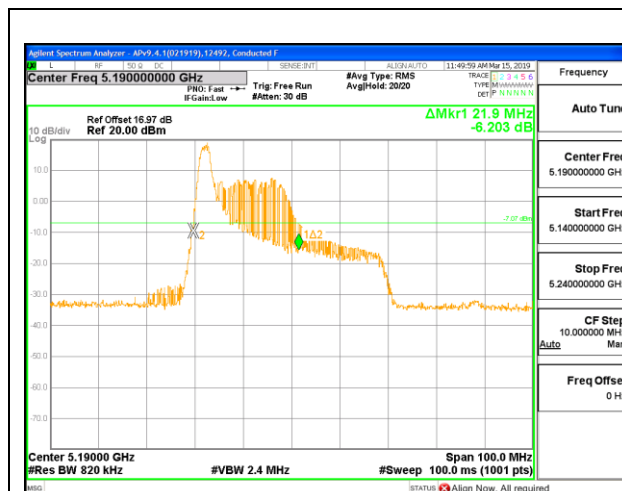
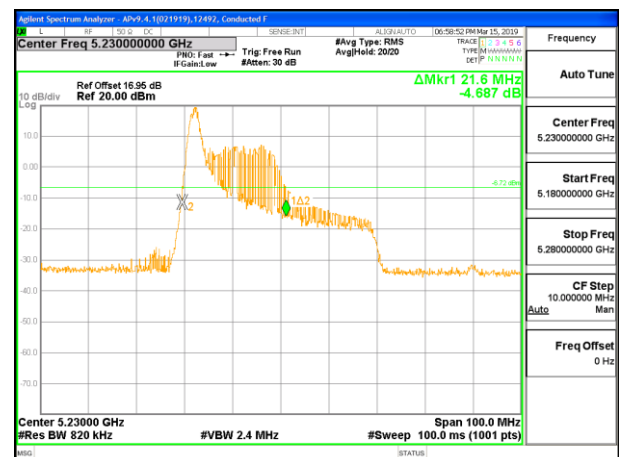


8.2.5. 802.11ax HE40 MODE IN THE 5.2 GHZ BAND**1TX Antenna 4 MODE – 484 Tones, RU Index 65**

Channel	Frequency (MHz)	26dB Bandwidth (MHz)
Low	5190	40.60
High	5230	41.90

**LOW CHANNEL****HIGH CHANNEL****1TX Antenna 4 MODE – 26 Tones, RU Index 0**

Channel	Frequency (MHz)	26dB Bandwidth (MHz)
Low	5190	21.90
High	5230	21.60

**LOW CHANNEL****HIGH CHANNEL**