TEST REPORT

Report Number: 13259315-E5V2

Applicant	:	APPLE INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A
Model	:	A2341
FCC ID	:	BCG-E3545A
IC	:	579C-E3545A
EUT Description	:	SMARTPHONE
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART E ISED RSS-247 ISSUE 2 ISED RSS-GEN ISSUE 5

Date of Issue:
September 21, 2020

Prepared by:
UL Verification Services Inc.
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NVLAP TESTING

NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	8/27/2020	Initial Issue	Chin Pang
V2	9/21/2020	Address TCB's Questions	Chin Pang

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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: SMARTPHONE

MODEL: A2341

SERIAL NUMBER: G6TCP01UQ5R9, G6TCM020Q5T6

DATE TESTED: MARCH 13, 2020 – AUGUST 24, 2020

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.

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2. TEST RESULT SUMMARY

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	Per ANSI C63.10, Section 12.2.
See Comment	RSS-GEN 6.7	26dB BW/99% OBW	Reporting purposes only	Per ANSI C63.10 Sections 6.9.2 and 6.9.3
15.407 (e)	RSS-247 6.2.4.1	6 dB BW	Complies	None.
15.407 (a) (1-4), (h) (1)	RSS-247 6.2	Output Power	Complies	None.
15.407 (a) (1-3, 5)	RSS-247 6.2	PSD	Complies	None.
15.209, 15.205, 15.407 (b)	RSS-GEN 8.9, 8.10, RSS-247 6.2	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Complies	None.

3. TEST METHODOLOGY

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

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

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

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5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	U_{Lab}
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.39 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.07 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%.

5.4. 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

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6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, 5G, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wideband, GPS, NFC and WPT. All models support at least one UICC based SIM. The second SIM is either an UICC based p-SIM (physical SIM) or e-SIM (electronic SIM). The device supports a built-in inductive charging transmitter and receiver. The rechargeable battery is not user accessible.

6.2. 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	19.62	91.62
5190-5230	802.11n HT40	20.69	117.22
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	16.25	42.17
5180-5240	802.11ax HE20, 242-Tones	19.73	93.97
5180-5240	802.11ax HE20, 26-Tones	11.75	14.96
5190-5230	802.11ax HE40, 484-Tones	20.77	119.40
5190-5230	802.11ax HE40, 26-Tones	11.73	14.89
5210	802.11ax HE80, 996 Tones	15.74	37.50
5210	802.11ax HE80, 26 Tones	11.74	14.93
5.2 GHz band, 2TX			
5180-5240	802.11n HT20 CDD	19.63	91.83
5180-5240	802.11n HT20 SDM/STBC	Covered by 802.11n HT20 2TX CDD	
5190-5230	802.11n HT40 CDD	22.02	159.22
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	18.31	67.76
5210	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5180-5240	802.11ax HE20 OFDMA, 242-Tones	19.73	93.97
5180-5240	802.11ax HE20 OFDMA, 26-Tones	11.73	14.89
5190-5230	802.11ax HE40 OFDMA, 484-Tones	22.01	158.85
5190-5230	802.11ax HE40 OFDMA, 26-Tones	11.72	14.86
5210	802.11ax HE80 OFDMA, 996-Tones	17.68	58.61
5210	802.11ax HE80 OFDMA, 26-Tones	11.66	14.66

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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	19.73	93.97
5270 - 5310	802.11n HT40	20.67	116.68
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	16.09	40.64
5260 - 5320	802.11ax HE20, 242-Tones	19.71	93.54
5260 - 5320	802.11ax HE20, 26-Tones	11.71	14.83
5270 - 5310	802.11ax HE40, 484-Tones	20.66	116.41
5270 - 5310	802.11ax HE40, 26-Tones	11.71	14.83
5290	802.11ax HE80, 996-Tones	15.69	37.07
5290	802.11ax HE80, 26-Tones	11.72	14.86
5.3 GHz band, 2TX			
5260 - 5320	802.11n HT20 CDD	19.72	93.76
5260 - 5320	802.11n HT20 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5270 - 5310	802.11n HT40 CDD	21.69	147.57
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	17.71	59.02
5290	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5260 - 5320	802.11ax HE20 OFDMA, 242-Tones	19.70	93.33
5260 - 5320	802.11ax HE20 OFDMA, 26-Tones	11.71	14.83
5270 - 5310	802.11ax HE40 OFDMA, 484-Tones	21.71	148.25
5270 - 5310	802.11ax HE40 OFDMA, 26-Tones	11.69	14.76
5290	802.11ax HE80 OFDMA, 996-Tones	17.74	59.43
5290	802.11ax HE80 OFDMA, 26-Tones	11.69	14.76

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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	19.71	93.54
5510-5710	802.11n HT40	20.80	120.23
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	21.40	138.04
5500-5720	802.11ax HE20, 242-Tones	19.71	93.54
5500-5720	802.11ax HE20, 26-Tones	11.73	14.89
5510-5710	802.11ax HE40, 484-Tones	20.75	118.85
5510-5710	802.11ax HE40, 26-Tones	11.74	14.93
5530-5690	802.11ax HE80, 996-Tones	21.23	132.74
5530-5690	802.11ax HE80, 26-Tones	11.72	14.86
5.6 GHz band, 2TX			
5500-5720	802.11n HT20 CDD	19.64	92.04
5500-5720	802.11n HT20 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5510-5710	802.11n HT40 CDD	21.56	143.22
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	21.67	146.89
5530-5690	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5500-5720	802.11ax HE20 OFDMA, 242-Tones	19.59	90.99
5500-5720	802.11ax HE20 OFDMA, 26-Tones	11.72	14.86
5510-5710	802.11ax HE40 OFDMA, 484-Tones	21.34	136.14
5510-5710	802.11ax HE40 OFDMA, 26-Tones	11.72	14.86
5530-5690	802.11ax HE80 OFDMA, 996-Tones	21.38	137.40
5530-5690	802.11ax HE80 OFDMA, 26-Tones	11.70	14.79

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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	21.17	130.92
5755-5795	802.11n HT40	20.77	119.40
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	20.14	103.28
5745-5825	802.11ax HE20, 242-Tones	21.24	133.05
5745-5825	802.11ax HE20, 26-Tones	21.25	133.35
5755-5795	802.11ax HE40, 484-Tones	20.69	117.22
5755-5795	802.11ax HE40, 26-Tones	20.75	118.85
5775	802.11ax HE80, 996-Tones	20.21	104.95
5775	802.11ax HE80, 26-Tones	21.23	132.74
5.8 GHz band, 2TX			
5745-5825	802.11n HT20 CDD	22.83	191.87
5745-5825	802.11n HT20 SDM/STBC	Covered by 802.11n HT40 2TX CDD	
5755-5795	802.11n HT40 CDD	22.48	177.01
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	21.83	152.41
5775	802.11ac VHT80 SDM/STBC	Covered by 802.11ac VHT80 2TX CDD	
5745-5825	802.11ax HE20 OFDMA, 242-Tones	22.83	191.87
5745-5825	802.11ax HE20 OFDMA, 26-Tones	22.83	191.87
5755-5795	802.11ax HE40 OFDMA, 484-Tones	22.48	177.01
5755-5795	802.11ax HE40 OFDMA, 26-Tones	22.50	177.83
5775	802.11ax HE80 OFDMA, 996-Tones	21.85	153.11
5775	802.11ax HE80 OFDMA, 26-Tones	21.78	150.66

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6.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	ANT 6 (dBi)	ANT 5 (dBi)
5150-5250	0.3	-2.6
5250-5350	1.4	-1.2
5500-5700	0.6	-0.2
5725-5825	-0.6	-1.7

6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 20_10_619_14

6.5. WORST-CASE CONFIGURATION AND MODE

The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z on ANT 6 and ANT 5, it was determined that X (Flatbed) orientation was the worst-case orientation for ANT 6. and Y (Landscape) orientation was the worst case for ANT 5 and 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 and 2TX HE mode 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.

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Investigated worst-case data rates as listed below were:

802.11n HT20mode: MCS0
802.11n HT40mode: MCS7
802.11ac VHT80 mode: MCS9
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.

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6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	Apple	A1989	C02YL3ZMJHC8	BCGA1989
Laptop 61W USBC-C AC/DC adapter	Liteon Technology	A1718	C4N711404U3GN8RAW	NA
EUT AC Adapter	Apple	A2305	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 ports**	**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 connected to a test laptop during the tests. Test software exercised the radio card.

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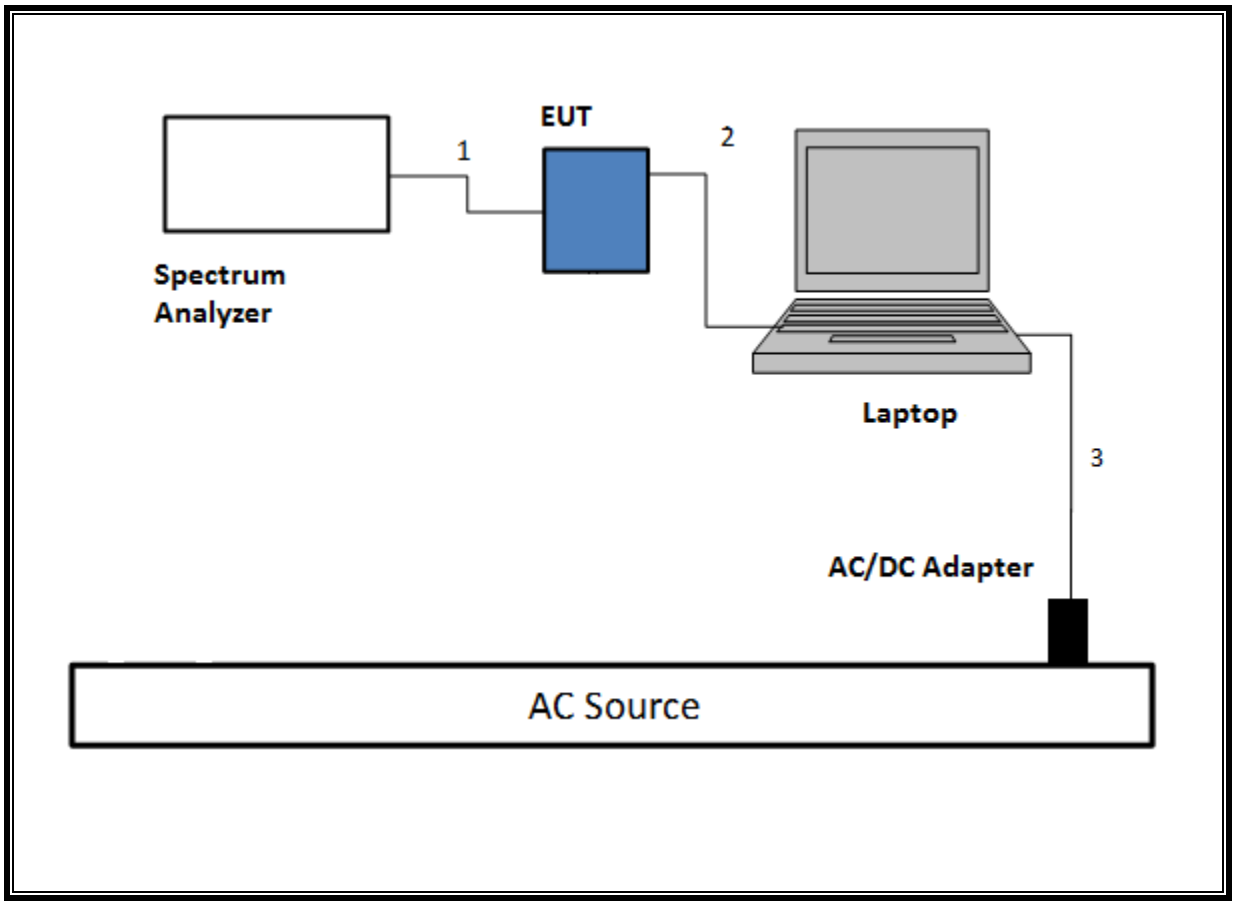
SETUP DIAGRAM FOR CONDUCTED TESTS



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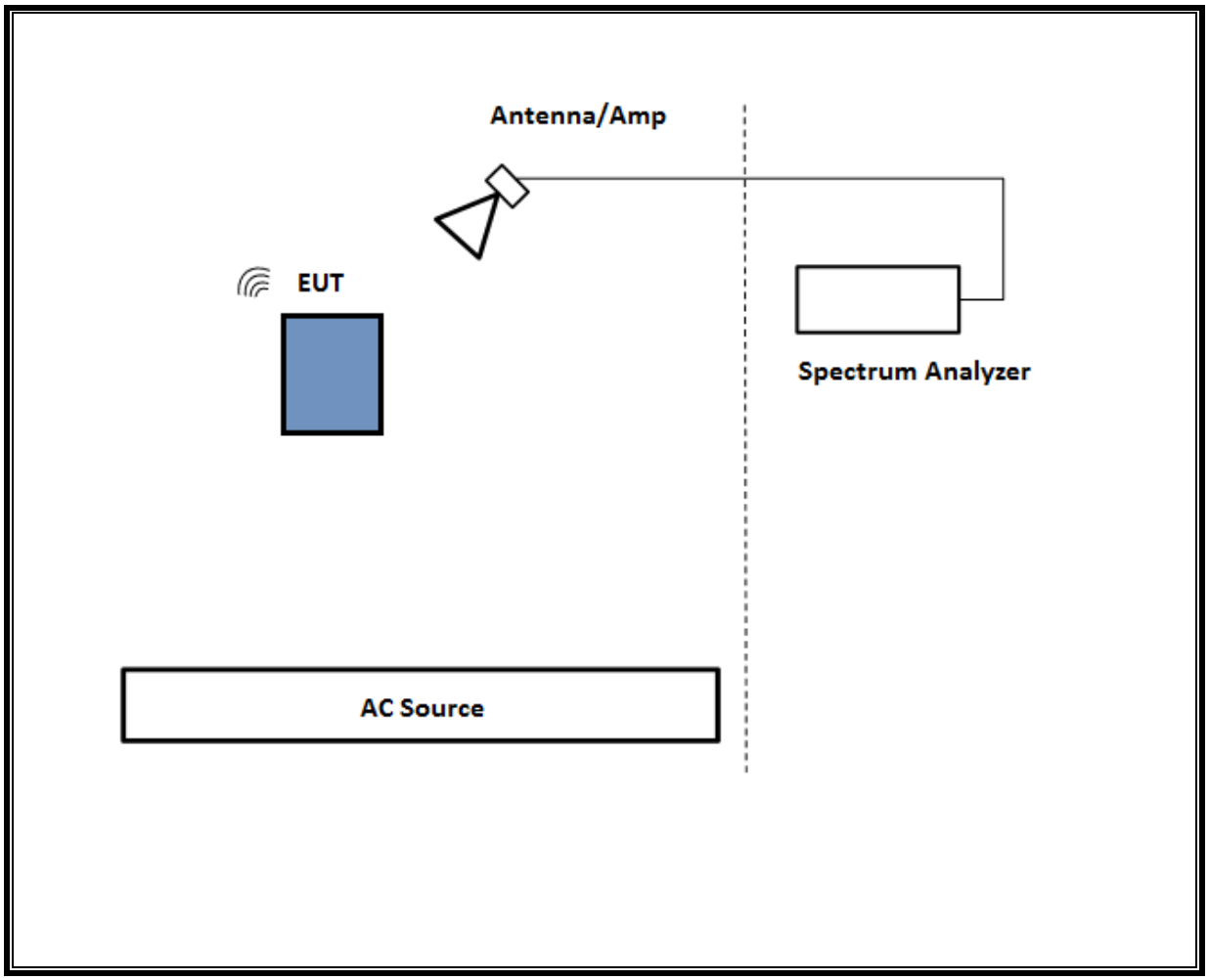
SETUP DIAGRAM FOR RADIATED TESTS Above 1GHz



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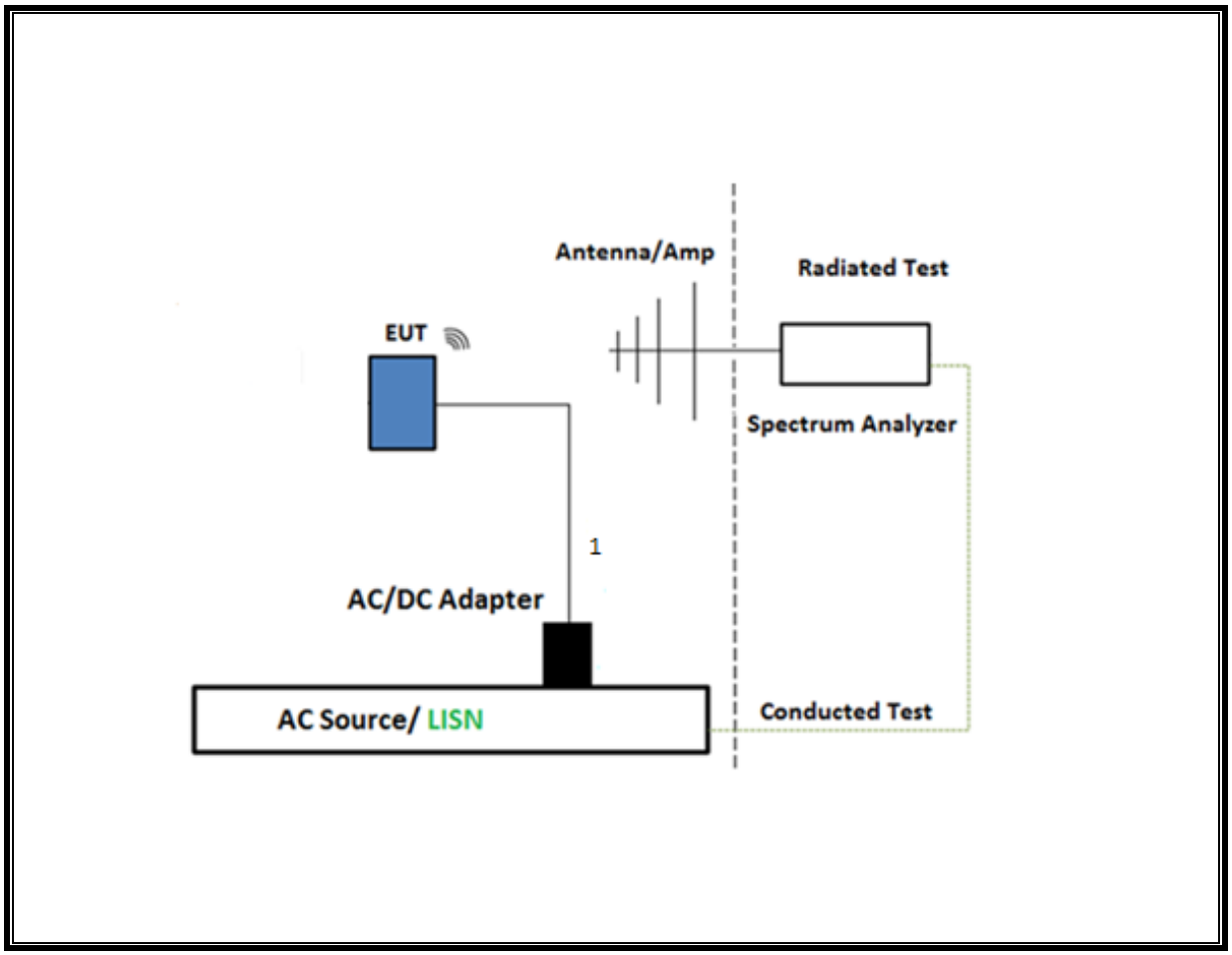
SETUP DIAGRAM FOR Below 1GHz and AC LINE CONDUCTED TEST



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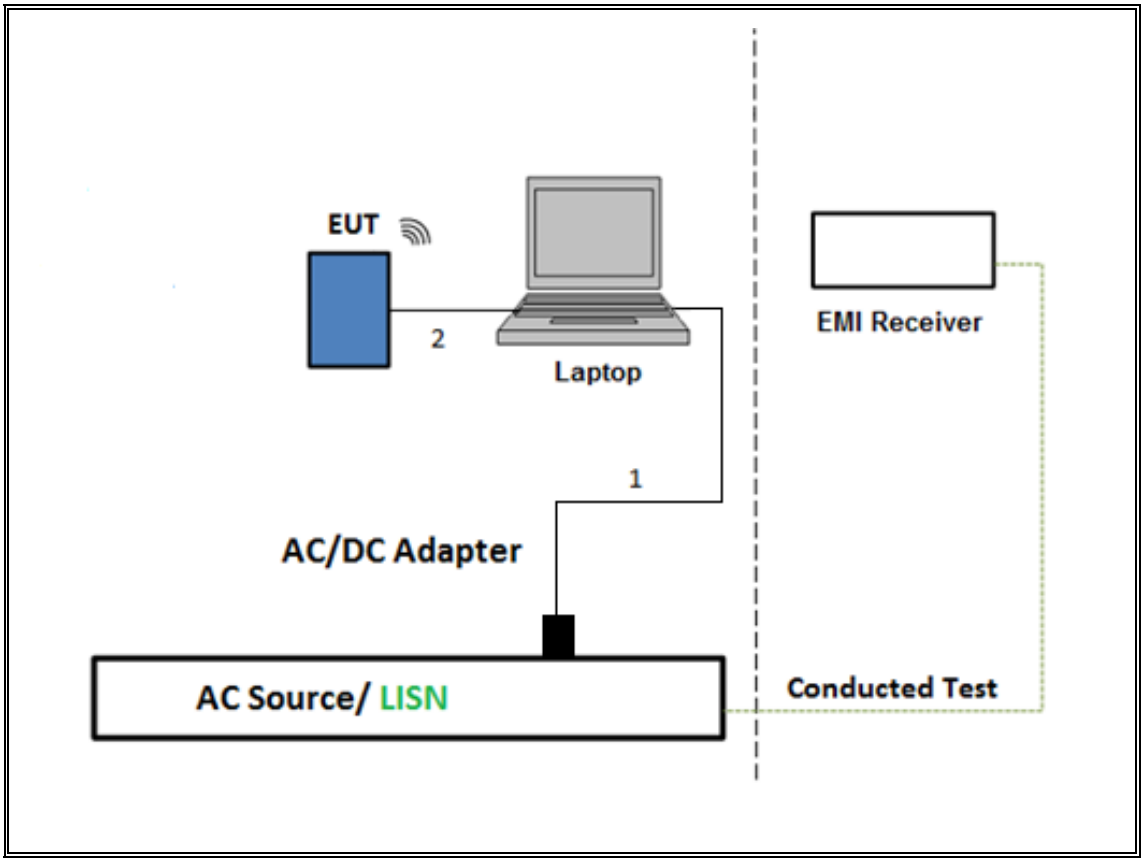
TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



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7. 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

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

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8. 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, Horn 1-18GHz	ETS Lindgren	3117	T346	05/14/2020	05/14/2019
*Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T931	05/11/2020	05/11/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T459	01/23/2021	01/23/2020
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T712	03/09/2021	03/09/2020
Amplifier, 1 to 18GHz	Amplical	AMP1G18-35	138301	01/14/2021	01/14/2020
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A	T1466	01/23/2021	01/23/2020
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T862	08/20/2020	08/20/2019
*RF Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	171460	08/24/2020	08/24/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T339	01/21/2021	01/21/2020
Antenna, Double Ridge Guide Horn Antenna	A.H. Systems, Inc.	SAS-571	T963	01/25/2021	01/25/2020
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T344	05/26/2021	05/26/2020
EMI Test Receiver	Rohde & Schwarz	ESW44	Pre0179372	02/25/2021	02/25/2020
Amplifier, 1 to 18GHz, 35dB	AMPLICAL	AMP1G18-35	T1569	01/30/2021	01/30/2020
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T863	11/01/2020	11/01/2019
Amplifier, 1 to 18GHz, 35dB	Amplical	AFS42-00101800-25-S-42	T1567	01/24/2021	01/24/2020
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T491	06/12/2021	06/12/2020
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T962	01/25/2021	01/25/2020
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T1165	05/18/2021	05/18/2020
*Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunsol Sciences Corp.	JB3	T408	08/23/2020	08/23/2019
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T300	01/23/2021	01/23/2020
Antenna Horn, 18 to 26GHz	ARA	SWH-28	T125	04/17/2021	04/17/2020
Antenna, Horn 26.5 to 40GHz	ARA	MWH-2640/B	PRE0182203	04/17/2021	04/17/2020
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	04/08/2021	04/08/2020
EMI Test Receiver	Rohde & Schwarz	ESW44	Pre0179522	02/20/2021	02/20/2020
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1454	01/23/2021	01/23/2020
Power Meter, P-series single channel	Keysight	N1911A	PRE0126090	01/21/2021	01/21/2020
Power Sensor	Keysight	N1921A	T1228	04/13/2021	04/13/2019
Antenna, Active Loop 9KHz to 30MHz	EMCO	6502	T1616	10/28/2020	10/28/2019
Amplifier, 26GHz to 40GHz	Miteq	TTA2640-35-HG	T1864	04/08/2021	04/08/2020

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AC Line Conducted					
Description	**Manufacturer**	**Model**	**ID Num**	**Cal Due**	**Last Cal**
EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESR	T1436	02/20/2021	02/20/2020
Power Cable, Line Conducted Emissions	UL	PR1	T861	10/27/2020	10/27/2019
LISN for Conducted Emissions CISPR-16	FISCHER CUSTOM COMMUNICATIONS	FCC-LISN-50/250-25-2-01	PRE0186446	01/23/2021	01/23/2020
UL AUTOMATION SOFTWARE					
Radiated Software	UL	UL EMC	Ver 9.5, Mar 6, 2020		
Conducted Software	UL	UL EMC	2020.2.26		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, February 21, 2020		

*Testing is completed before equipment expiration date.

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9. ANTENNA PORT TEST RESULTS

9.1. 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 MCS0	1.919	1.945	0.987	98.70%	0.00	0.010
802.11n HT20 1Tx MCS7	0.228	0.247	0.922	92.23%	0.35	4.386
802.11n HT20 CDD MCS0	1.919	1.937	0.991	99.07%	0.00	0.010
802.11n HT20 CDD MCS7	0.136	0.156	0.875	87.46%	0.58	7.353
802.11n HT40 1Tx MCS0	0.943	0.974	0.968	96.77%	0.14	1.061
802.11n HT40 1Tx MCS7	0.128	0.148	0.860	86.04%	0.65	7.832
802.11n HT40 CDD MCS0	0.495	0.515	0.961	96.12%	0.17	2.020
802.11n HT40 CDD MCS7	0.088	0.108	0.816	81.63%	0.88	11.364
802.11ac VHT80 1Tx MCS0	0.460	0.484	0.951	95.09%	0.22	2.174
802.11ac VHT80 1Tx MCS9	0.072	0.092	0.784	78.43%	1.06	13.889
802.11ac VHT80 CDD MCS0	0.256	0.276	0.928	92.75%	0.33	3.906
802.11ac VHT80 CDD MCS9	0.060	0.080	0.750	75.00%	1.25	16.667
802.11ax HE20 1Tx, MCS0	1.562	1.587	0.984	98.42%	0.00	0.010
802.11ax HE20 1Tx, MCS11	1.561	1.581	0.987	98.71%	0.00	0.010
802.11ax HE20 OFDMA, MCS0	1.560	1.583	0.986	98.58%	0.00	0.010
802.11ax HE20 OFDMA, MCS11	1.561	1.581	0.987	98.71%	0.00	0.010
802.11ax HE40 1Tx, MCS0	1.545	1.566	0.987	98.66%	0.00	0.010
802.11ax HE40 1Tx, MCS11	1.548	1.569	0.987	98.68%	0.00	0.010
802.11ax HE40 OFDMA, MCS0	1.548	1.570	0.986	98.57%	0.00	0.010
802.11ax HE40 OFDMA, MCS11	1.546	1.566	0.987	98.68%	0.00	0.010
802.11ax HE80 1Tx, MCS0	1.474	1.497	0.985	98.46%	0.00	0.010
802.11ax HE80 1Tx, MCS11	1.474	1.495	0.986	98.62%	0.00	0.010
802.11ax HE80 OFDMA, MCS0	3.970	4.010	0.990	99.00%	0.00	0.010
802.11ax HE80 OFDMA, MCS11	1.474	1.497	0.985	98.46%	0.00	0.010

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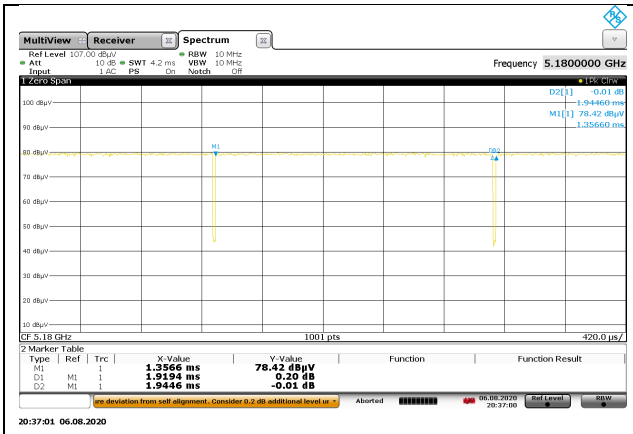
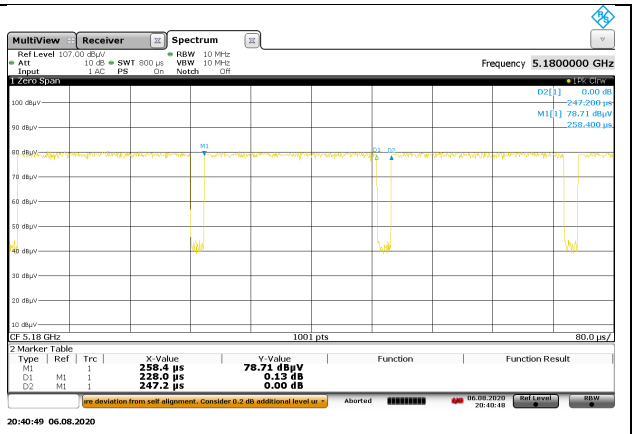
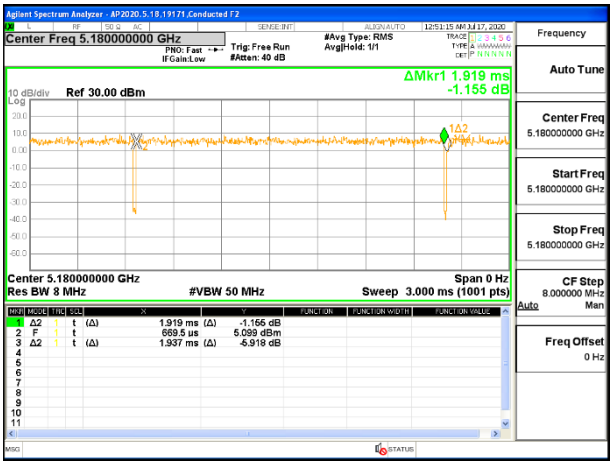
DUTY CYCLE PLOTS



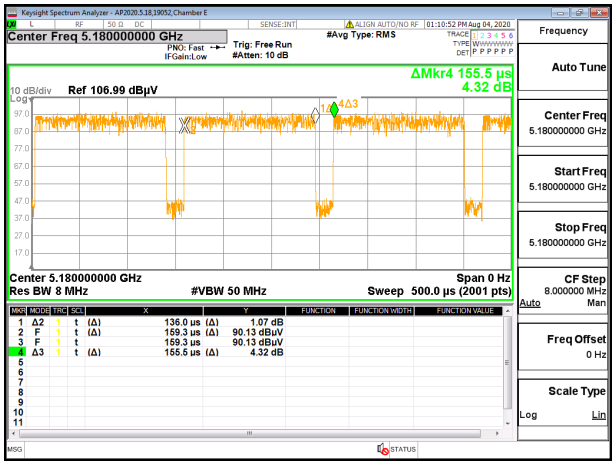
DUTY CYCLE 802.11n HT20 1TX MODE MCS0



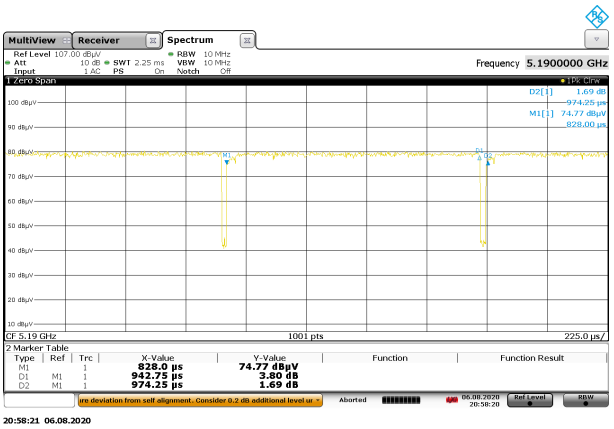
DUTY CYCLE 802.11n HT20 1TX MODE MCS7



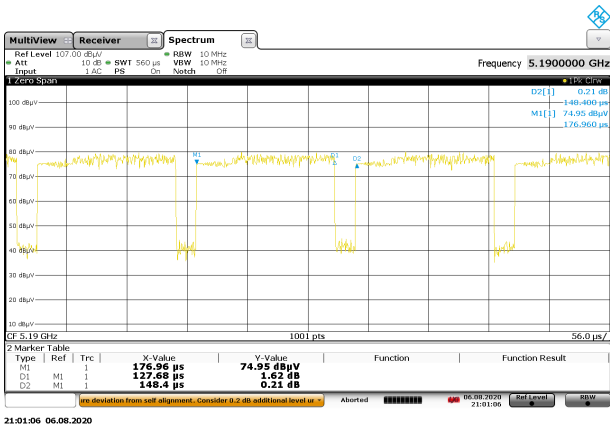
DUTY CYCLE 802.11n HT20 CDD MODE MCS0



DUTY CYCLE 802.11n HT20 CDD MODE MCS7



DUTY CYCLE 802.11n HT40 1TX MODE MCS0



DUTY CYCLE 802.11n HT40 1TX MODE MCS7

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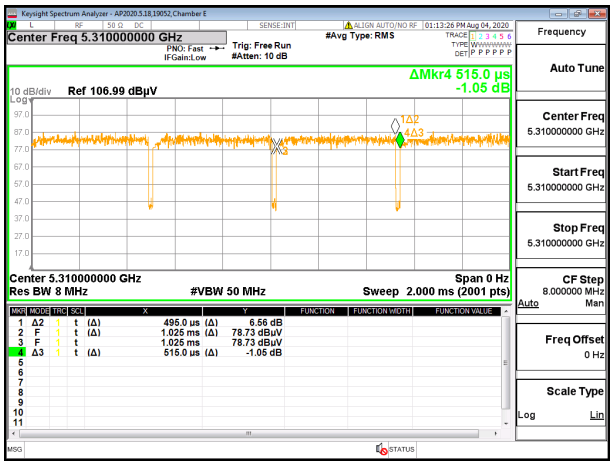
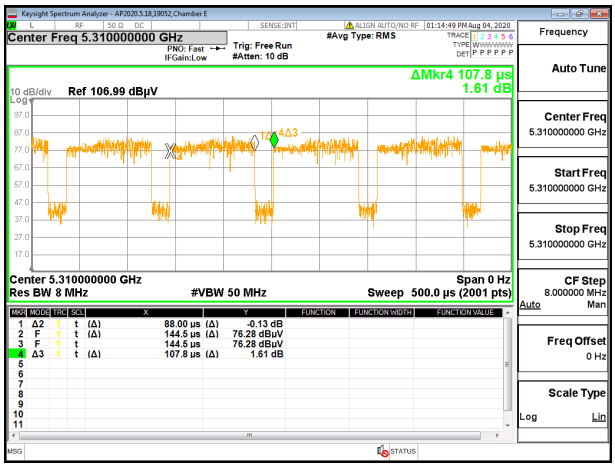
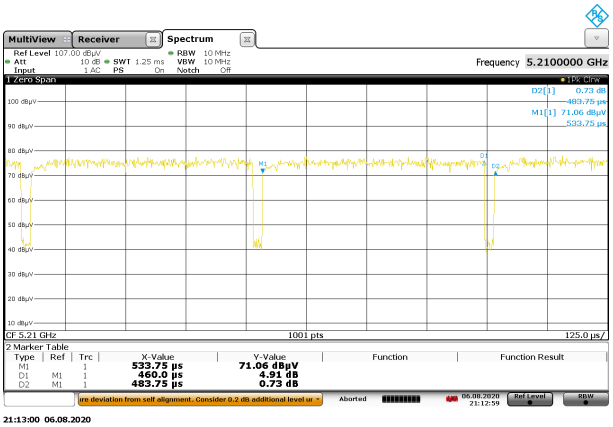


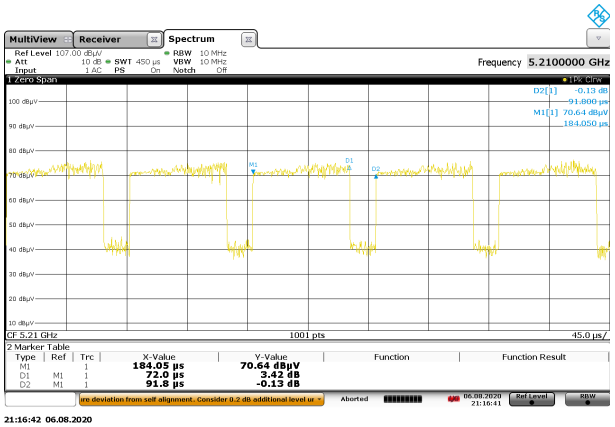
DUTY CYCLE 802.11n HT40 CDD MODE MCS0



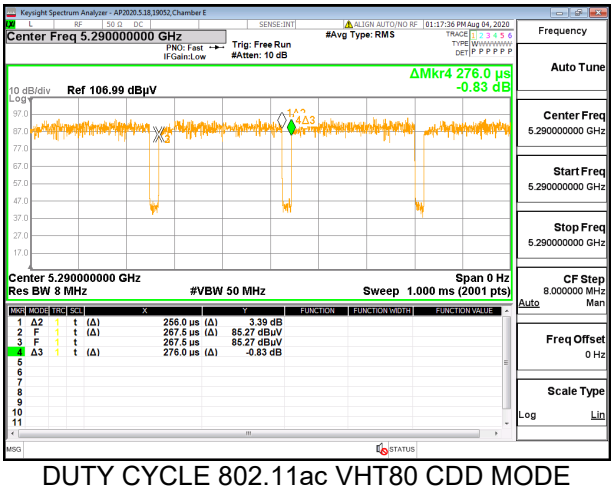
DUTY CYCLE 802.11n HT40 CDD MODE MCS7



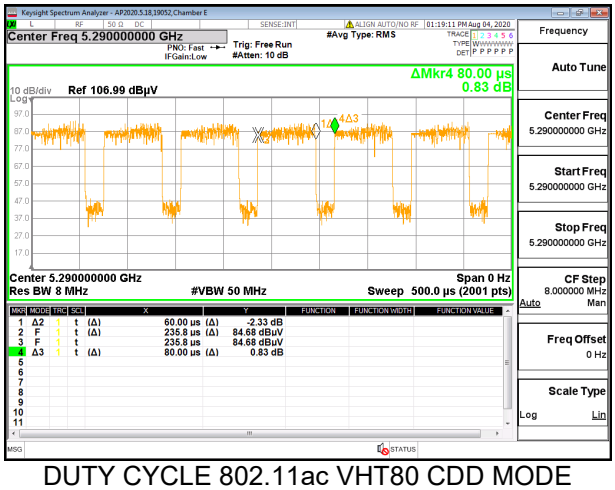
DUTY CYCLE 802.11ac VHT80 1TX MODE MCS0



DUTY CYCLE 802.11ac VHT80 1TX MODE MCS9



DUTY CYCLE 802.11ac VHT80 CDD MODE MCS0



DUTY CYCLE 802.11ac VHT80 CDD MODE MCS9

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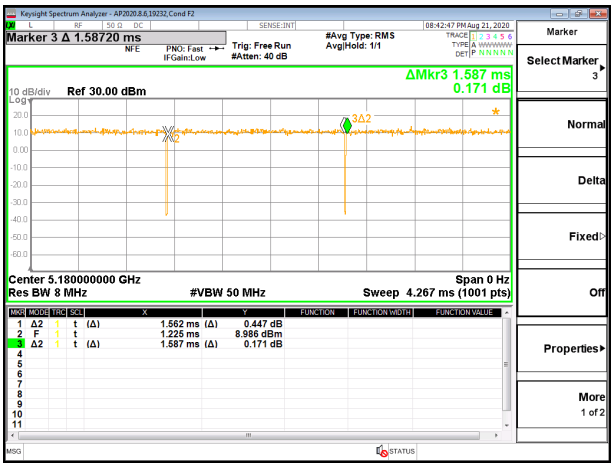
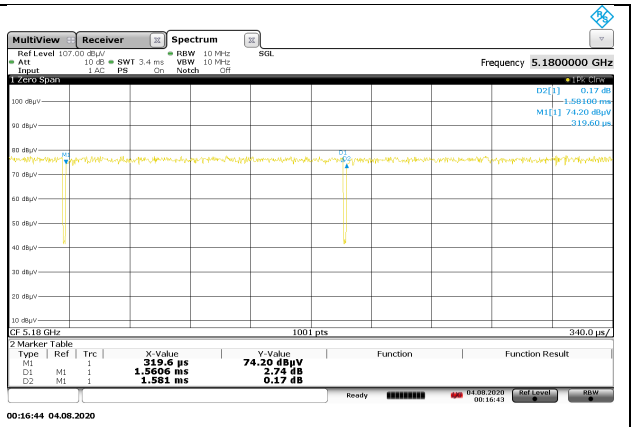
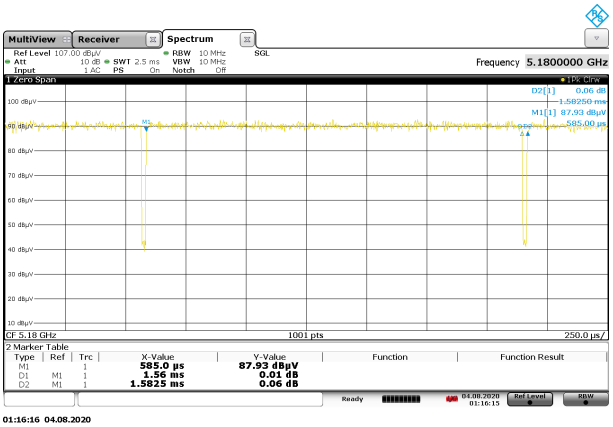


802.11ax HE20 1Tx, MCS0



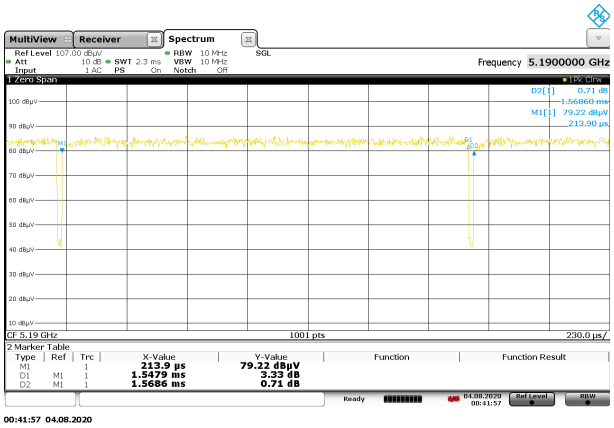
802.11ax HE20 1Tx, MCS11



802.11ax HE20 OFDMA, MCS0

802.11ax HE20 OFDMA, MCS11

802.11ax HE40 1Tx, MCS0



802.11ax HE40 1Tx, MCS11

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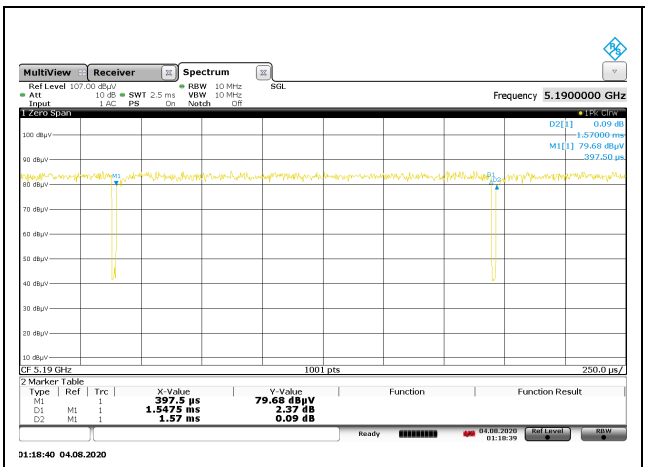
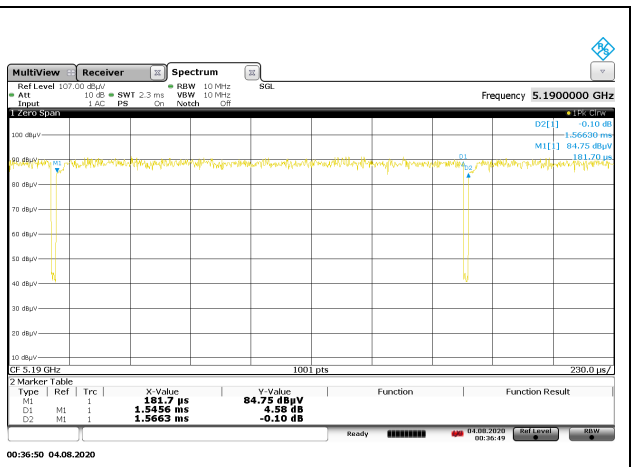
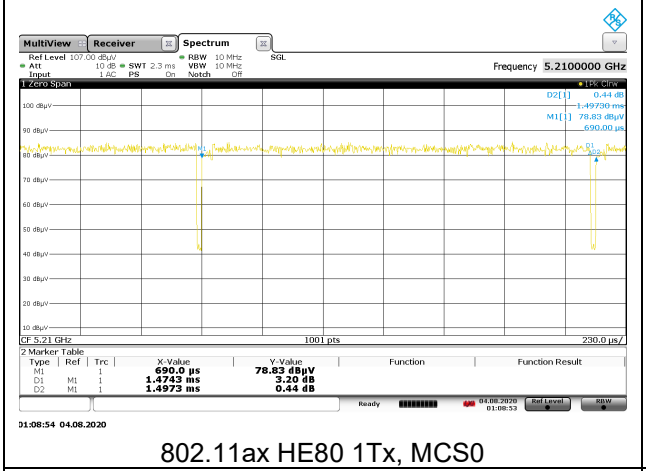


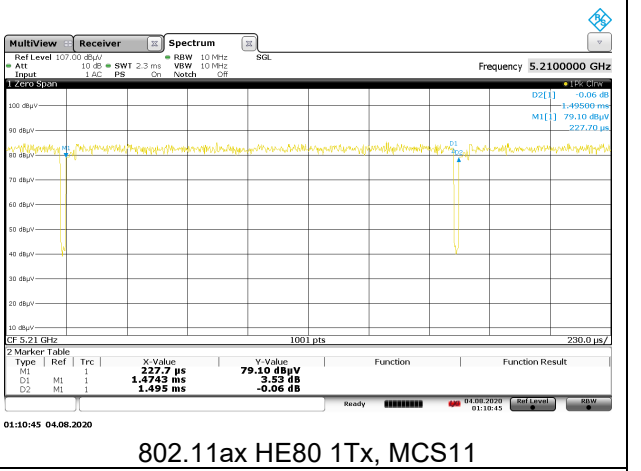
802.11ax HE40 OFDMA, MCS0



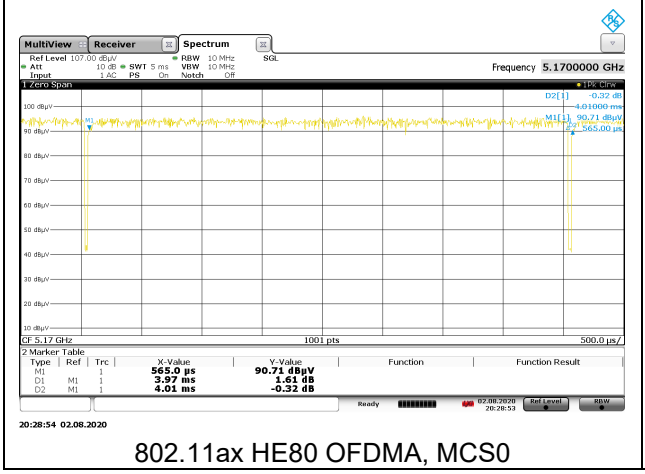
802.11ax HE40 OFDMA, MCS11



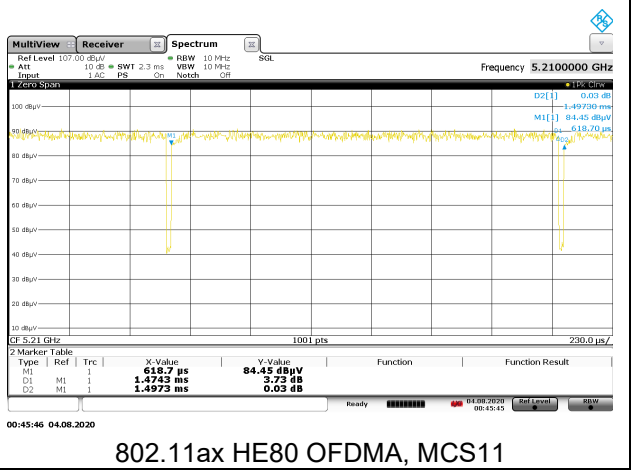
802.11ax HE80 1Tx, MCS0



802.11ax HE80 1Tx, MCS11



802.11ax HE80 OFDMA, MCS0



802.11ax HE80 OFDMA, MCS11

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9.2. 99% and 26dB BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

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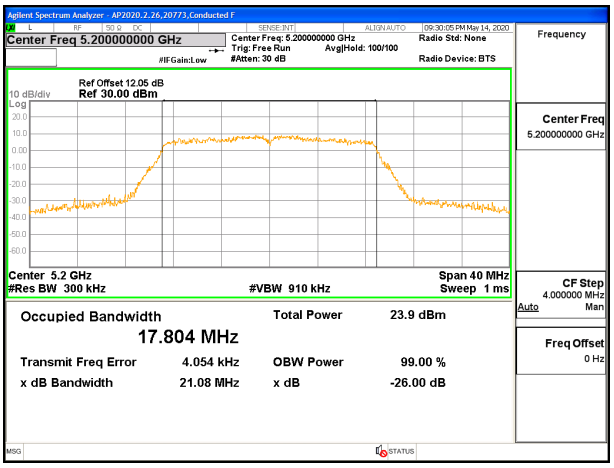
9.2.1. 802.11n HT20 MODE IN THE 5.2 GHz BAND

1TX ANT 6 MODE

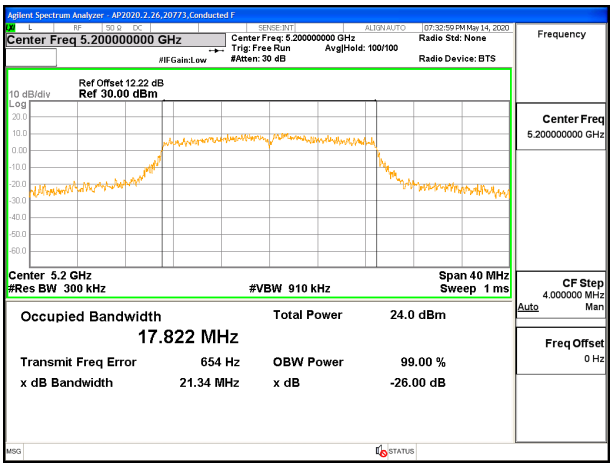
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	17.764	21.19
Mid	5200	17.804	21.08
High	5240	17.807	21.17



MID CHANNEL

1TX ANT 5 MODE

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	17.804	21.14
Mid	5200	17.822	21.34
High	5240	17.843	21.31



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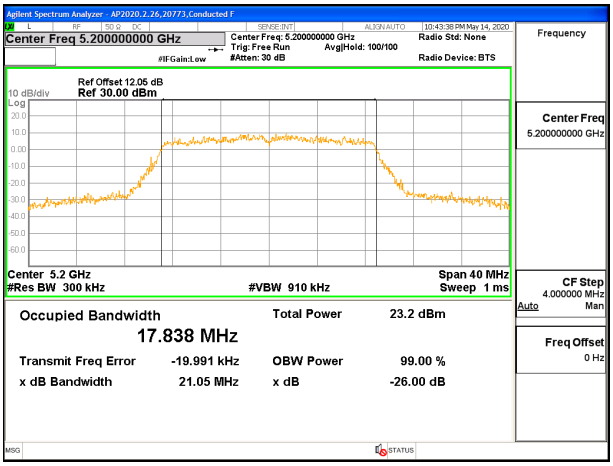
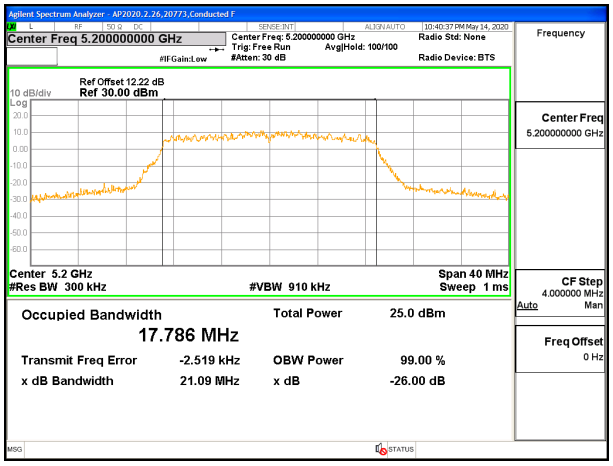
2TX ANT 6 + ANT 5 CDD MODE

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5180	17.818	21.04	17.807	21.19
Mid	5200	17.838	21.05	17.786	21.09
High	5240	17.810	21.08	17.827	21.20



MID CHANNEL [ANT 6]



MID CHANNEL [ANT 5]

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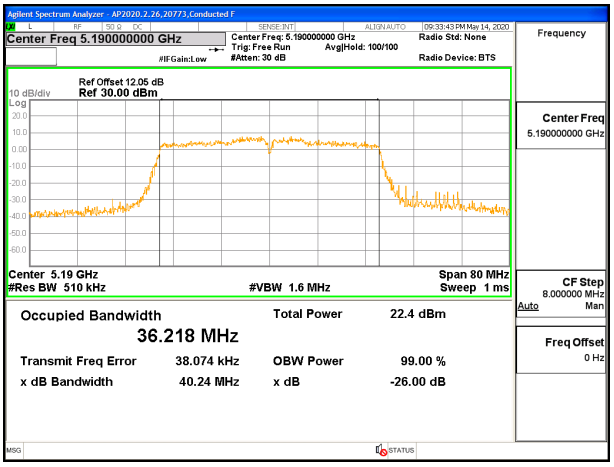
9.2.2. 802.11n HT40 MODE IN THE 5.2 GHz BAND

1TX ANT 6 MODE

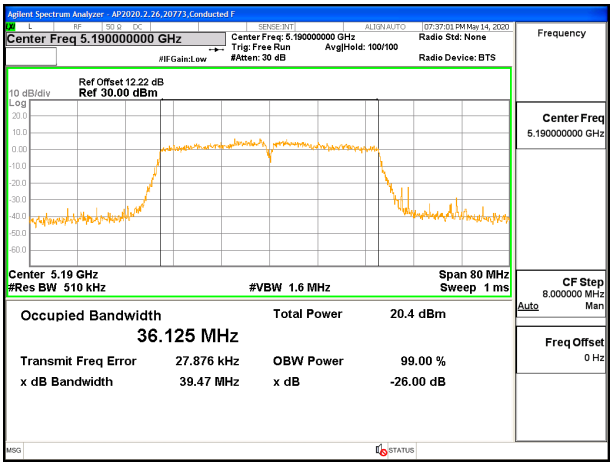
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	36.218	40.24
High	5230	36.218	40.13



LOW CHANNEL

1TX ANT 5 MODE

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	36.125	39.47
High	5230	36.149	39.91



LOW CHANNEL

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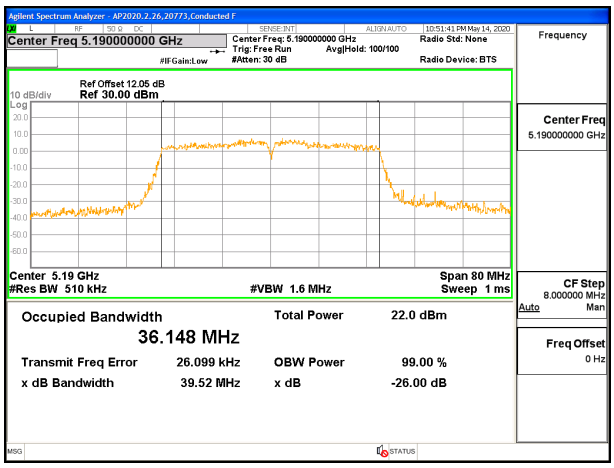
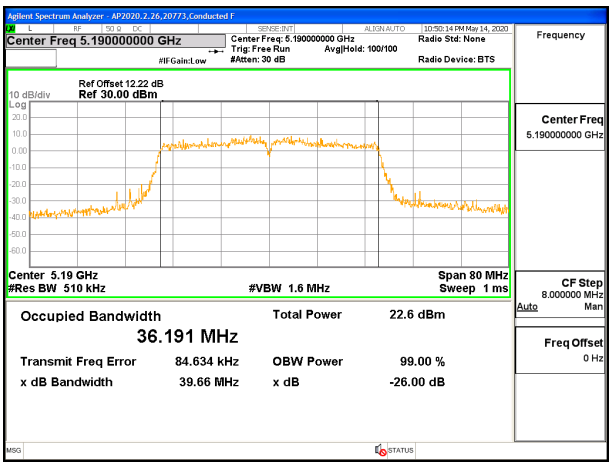
2TX ANT 6 + ANT 5 CDD MODE

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5190	36.148	39.52	36.191	39.66
High	5230	36.208	39.57	36.241	39.69



LOW CHANNEL [ANT 6]



LOW CHANNEL [ANT 5]

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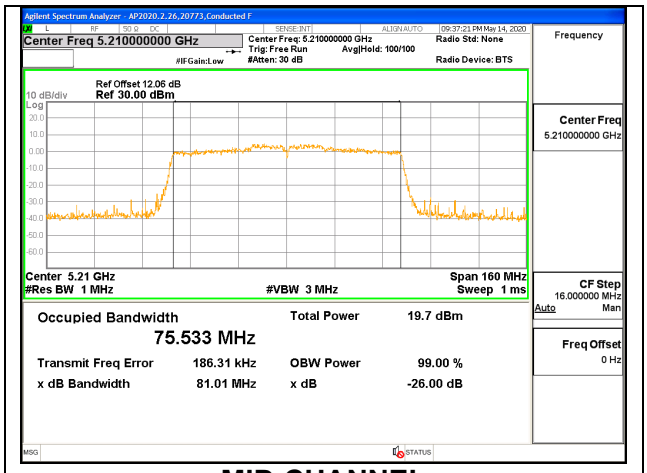
9.2.3. 802.11ac VHT80MODE IN THE 5.2 GHz BAND

1TX ANT 6 MODE

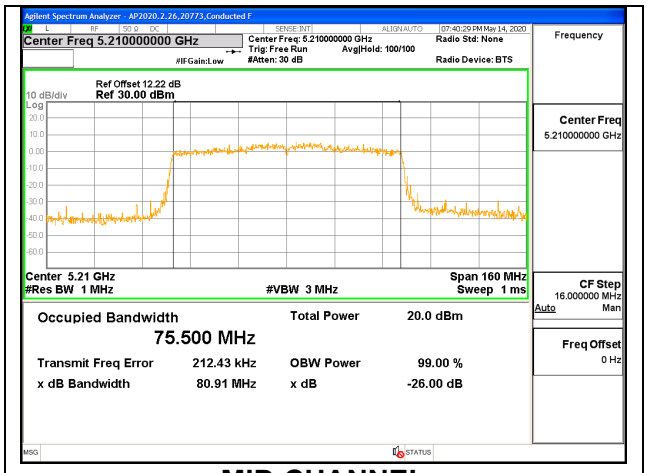
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	75.533	81.01



MID CHANNEL

1TX ANT 5 MODE

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	75.500	80.91



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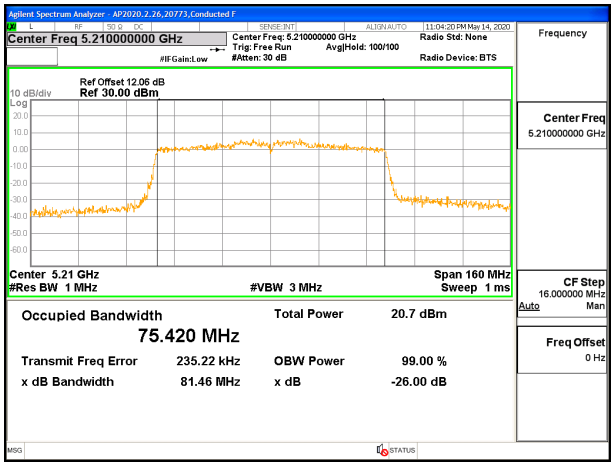
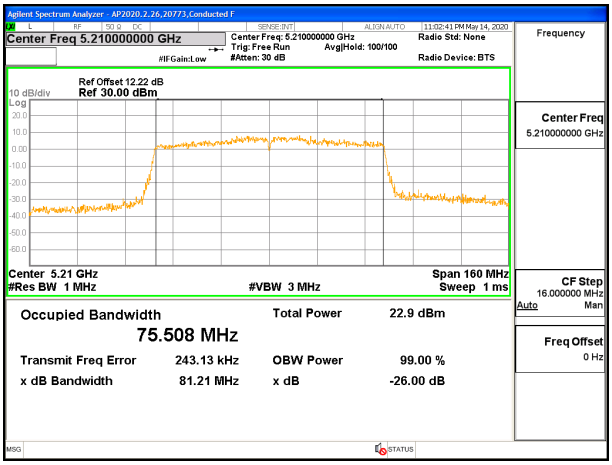
2TX ANT 6 + ANT 5 CDD MODE

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Mid	5210	75.420	81.46	75.508	81.21



MID CHANNEL [ANT 6]



MID CHANNEL [ANT 5]

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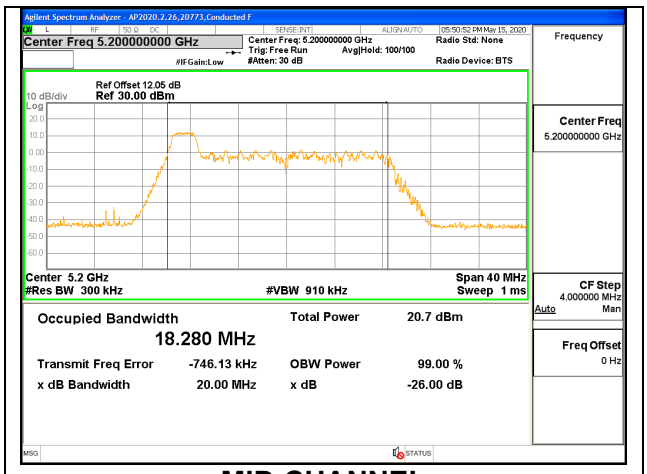
9.2.4. 802.11ax HE20 MODE IN THE 5.2 GHz BAND

1TX ANT 6 MODE: 26 Tones, RU Index 0

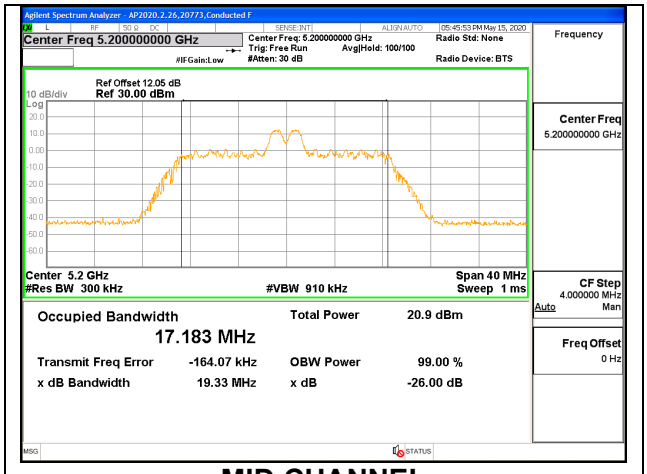
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	18.392	20.05
Mid	5200	18.280	20.00
High	5240	18.457	20.08



MID CHANNEL

1TX ANT 6 MODE: 26 Tones, RU Index 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	17.309	19.33
Mid	5200	17.183	19.33
High	5240	17.303	19.26



MID CHANNEL

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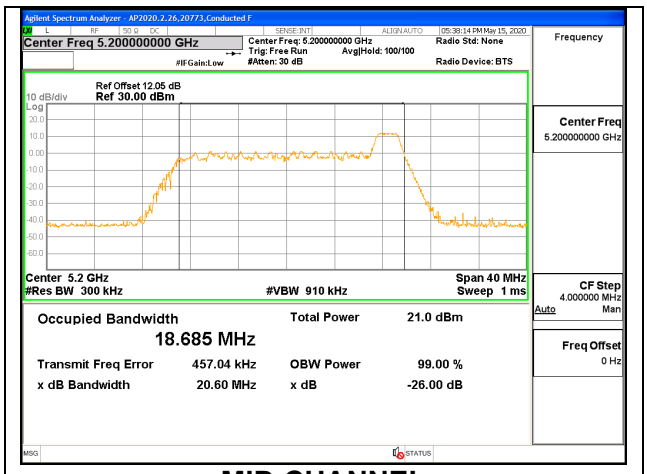
1TX ANT 6 MODE: 26 Tones, RU Index 8

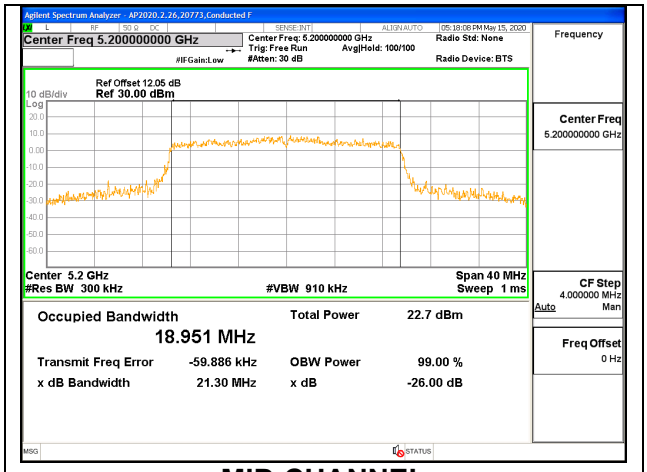
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	18.503	20.45
Mid	5200	18.685	20.60
High	5240	18.651	20.59



MID CHANNEL

1TX ANT 6 MODE: 242 Tones, RU Index 61

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	18.970	21.18
Mid	5200	18.951	21.30
High	5240	18.913	21.02



MID CHANNEL

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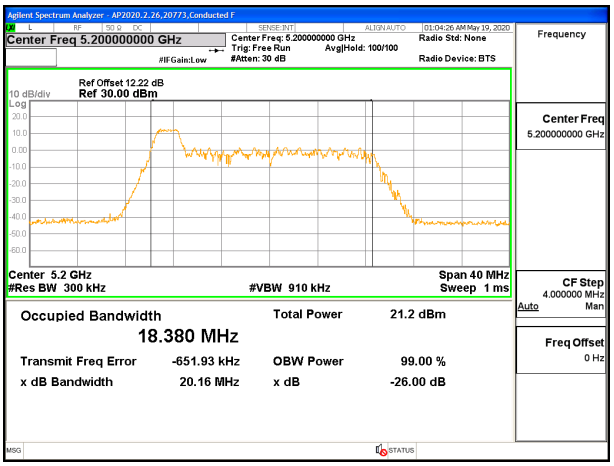
1TX ANT 5 MODE: 26 Tones, RU Index 0

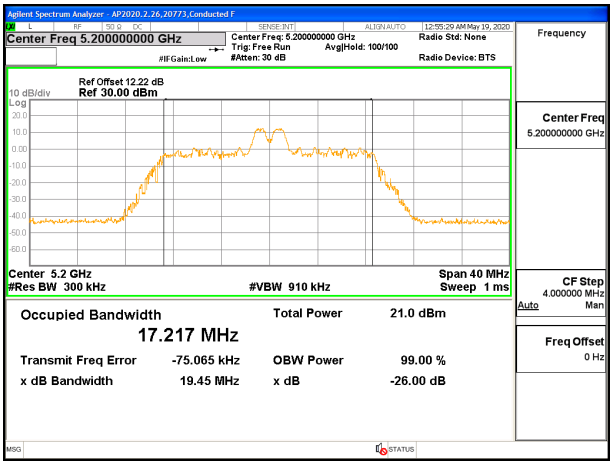
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	18.310	19.70
Mid	5200	18.380	20.16
High	5240	18.410	20.02



MID CHANNEL

1TX ANT 5 MODE: 26 Tones, RU Index 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	17.255	19.27
Mid	5200	17.217	19.45
High	5240	17.275	19.20



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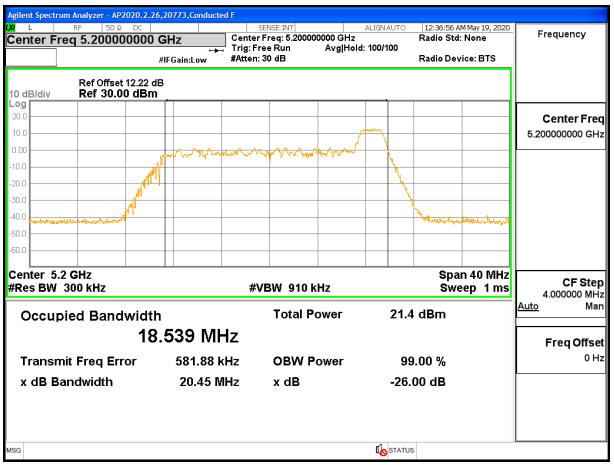
1TX ANT 5 MODE: 26 Tones, RU Index 8

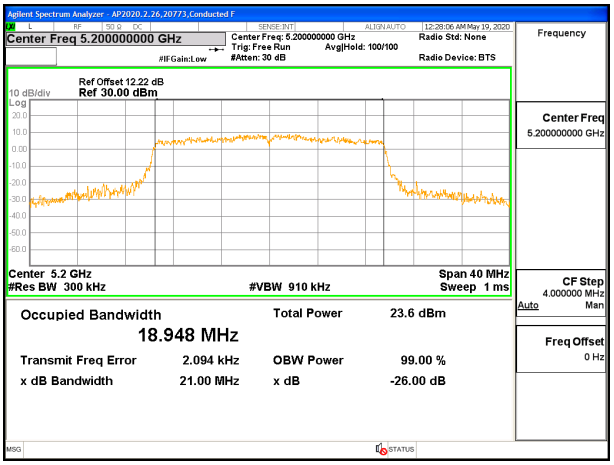
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	18.518	20.55
Mid	5200	18.539	20.45
High	5240	18.523	20.53



MID CHANNEL

1TX ANT 5 MODE: 242 Tones, RU Index 61

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5180	18.929	21.54
Mid	5200	18.948	21.00
High	5240	18.969	21.00



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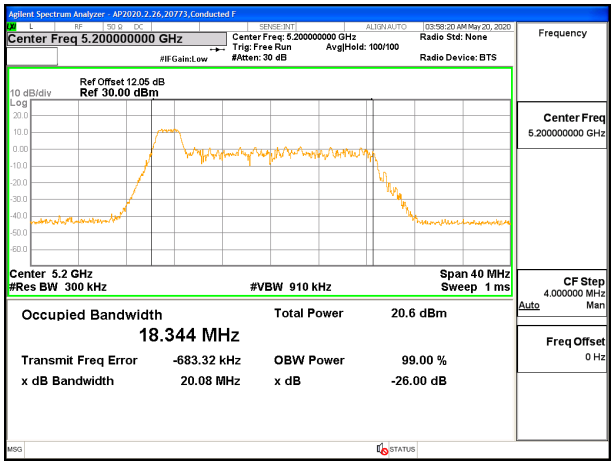
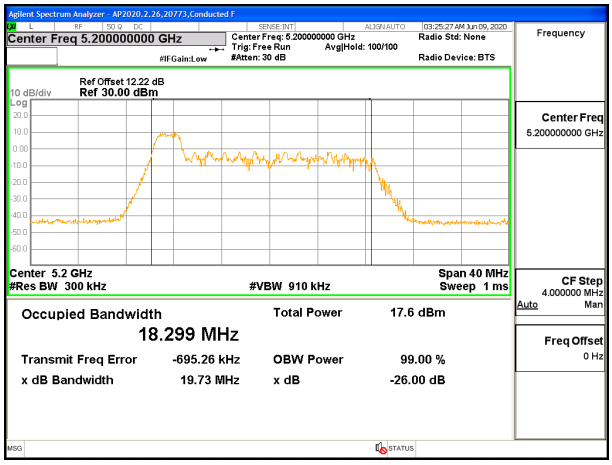
2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 0

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5180	18.380	20.09	18.353	19.58
Mid	5200	18.344	20.08	18.299	19.73
High	5240	18.416	19.99	18.341	19.72



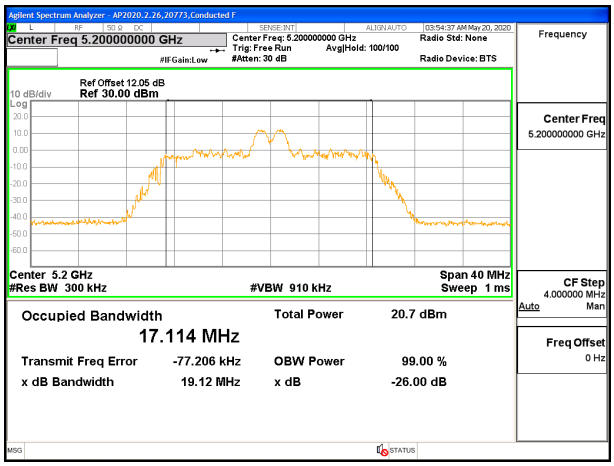
MID CHANNEL [ANT 6]



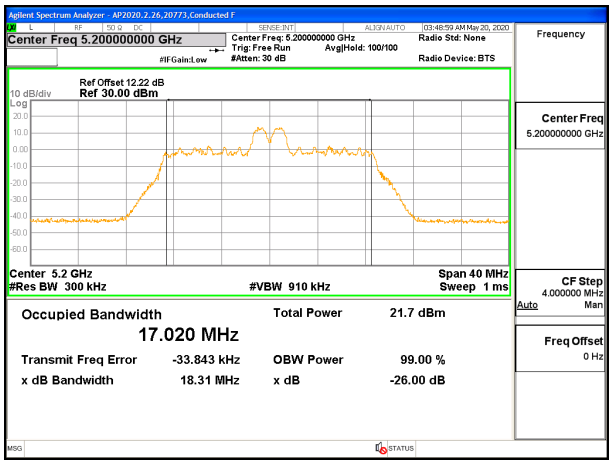
MID CHANNEL [ANT 5]

2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 4

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5180	17.167	19.45	17.027	18.25
Mid	5200	17.114	19.12	17.020	18.31
High	5240	17.293	19.03	17.013	18.19



MID CHANNEL [ANT 6]



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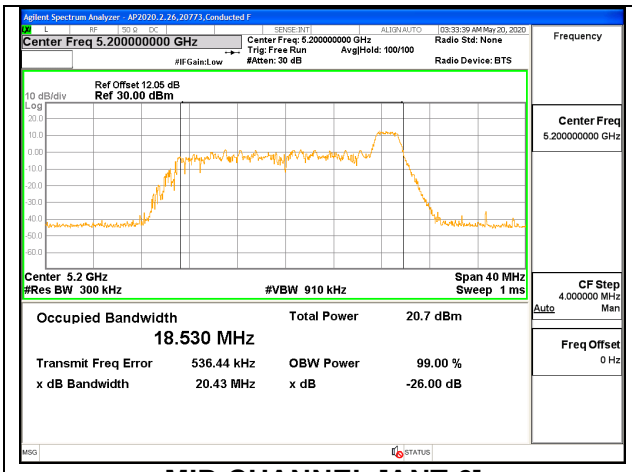
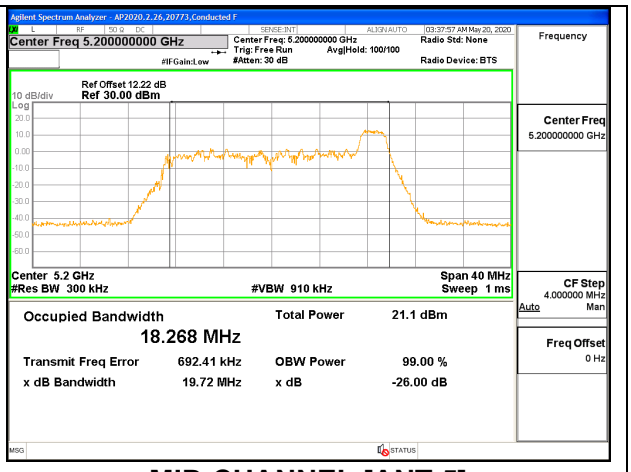
2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 8

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5180	18.279	20.45	18.406	19.65
Mid	5200	18.530	20.43	18.268	19.72
High	5240	18.659	20.65	18.372	19.64



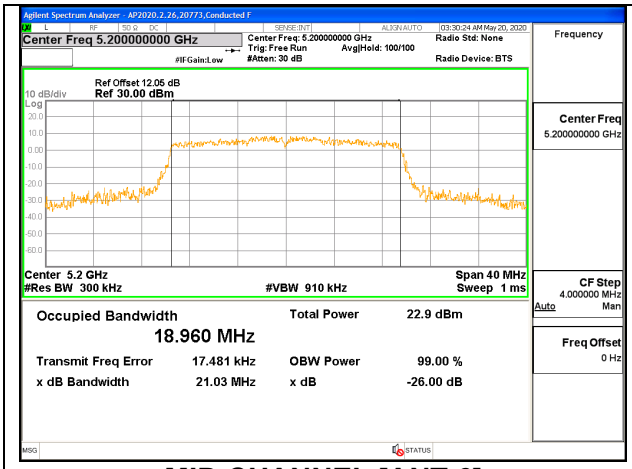
MID CHANNEL [ANT 6]



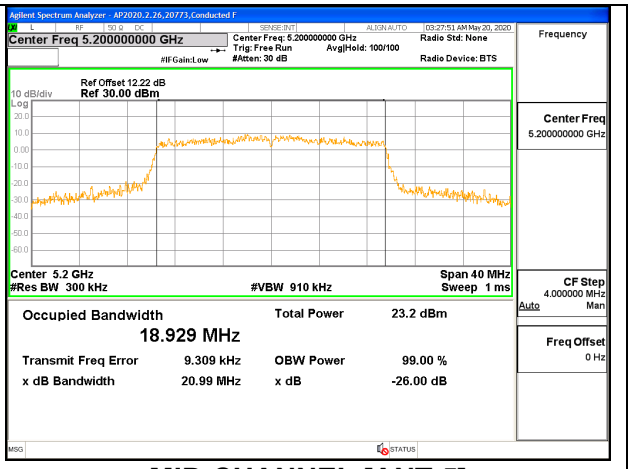
MID CHANNEL [ANT 5]

2TX ANT 6 + ANT 5 OFDMA MODE: 242 Tones, RU Index 61

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5180	18.945	20.86	18.932	21.37
Mid	5200	18.960	21.03	18.929	20.99
High	5240	18.914	21.04	18.917	21.09



MID CHANNEL [ANT 6]



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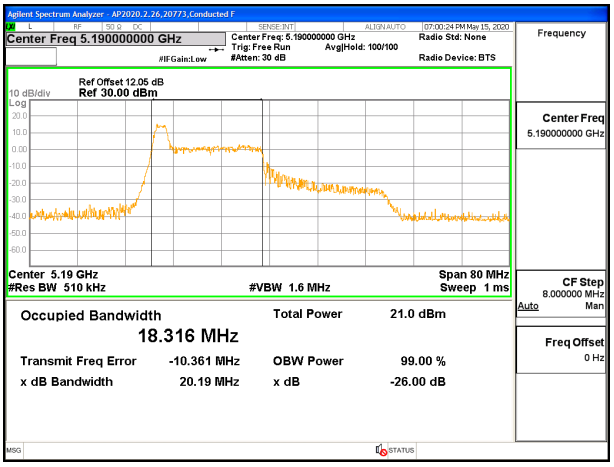
9.2.5. 802.11ax HE40 MODE IN THE 5.2 GHz BAND

1TX ANT 6 MODE: 26 Tones, RU Index 0

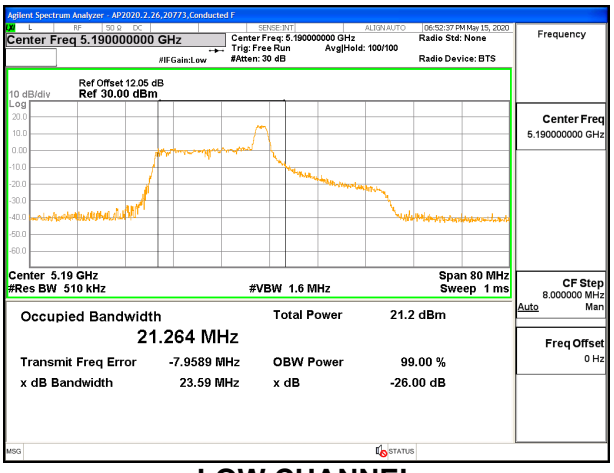
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	18.316	20.19
High	5230	18.481	20.31



LOW CHANNEL

1TX ANT 6 MODE: 26 Tones, RU Index 8

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	21.264	23.59
High	5230	21.631	23.38



LOW CHANNEL

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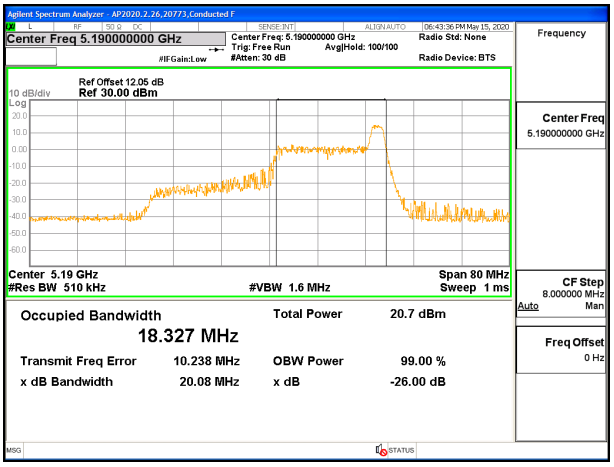
1TX ANT 6 MODE: 26 Tones, RU Index 17

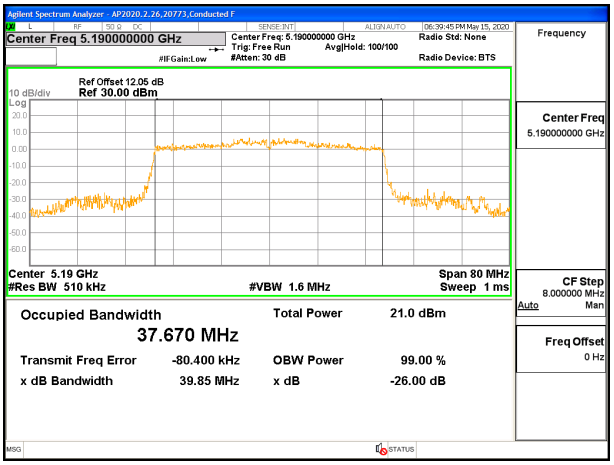
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	18.327	20.08
High	5230	18.425	20.73



LOW CHANNEL

1TX ANT 6 MODE: 484 Tones, RU Index 65

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	37.670	39.85
High	5230	37.563	39.52



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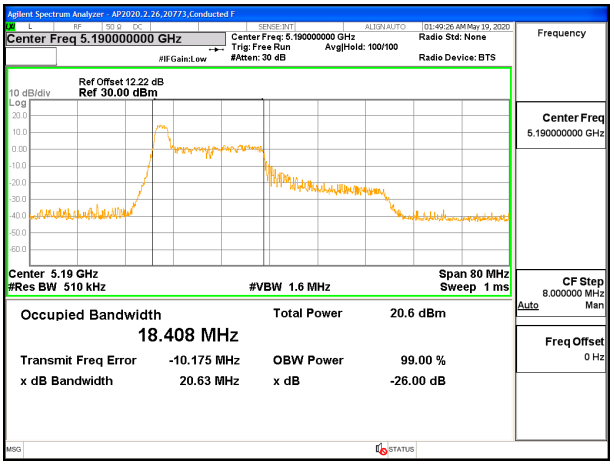
1TX ANT 5 MODE: 26 Tones, RU Index 0

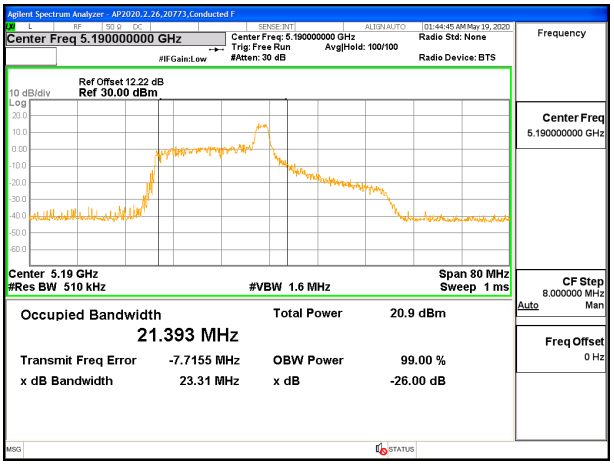
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	18.408	20.63
High	5230	18.225	20.94



LOW CHANNEL

1TX ANT 5 MODE: 26 Tones, RU Index 8

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	21.393	23.31
High	5230	21.590	23.12



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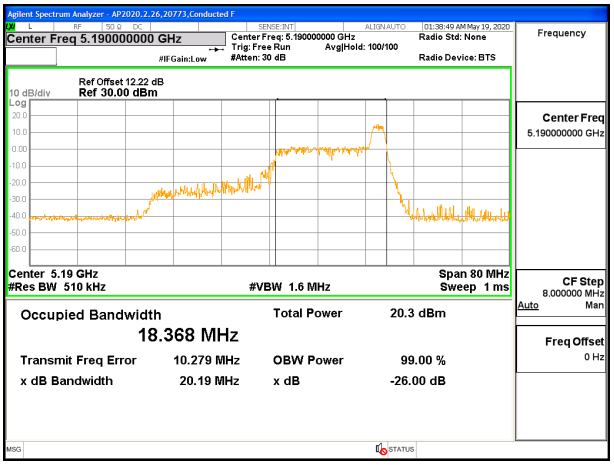
1TX ANT 5 MODE: 26 Tones, RU Index 17

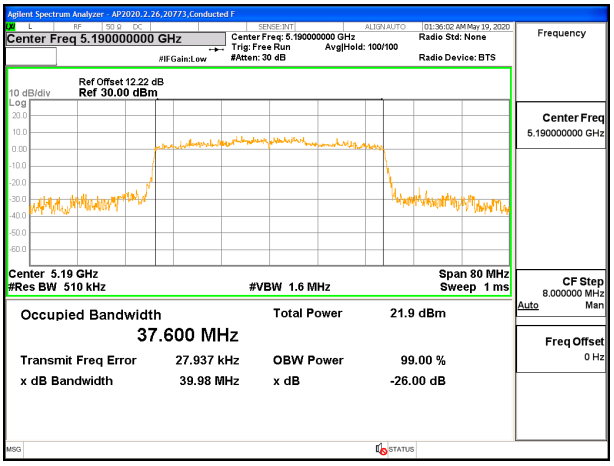
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	18.368	20.19
High	5230	18.387	20.16



LOW CHANNEL

1TX ANT 5 MODE: 484 Tones, RU Index 65

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Low	5190	37.600	39.98
High	5230	37.507	39.71



LOW CHANNEL

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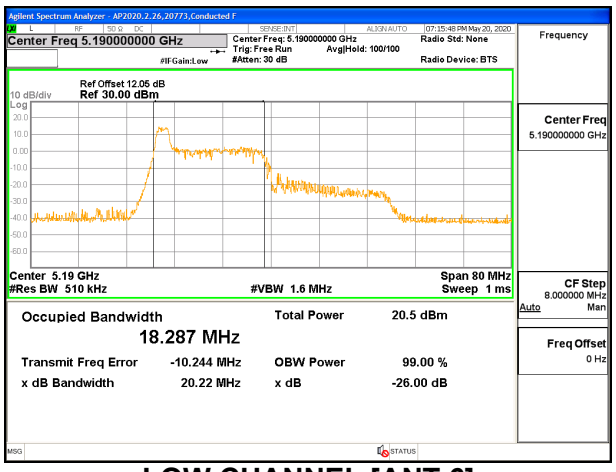
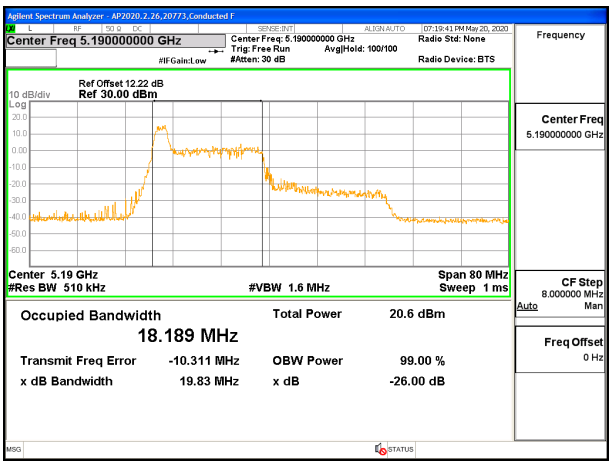
2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 0

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5190	18.287	20.22	18.189	19.83
High	5230	18.361	19.79	18.380	19.77



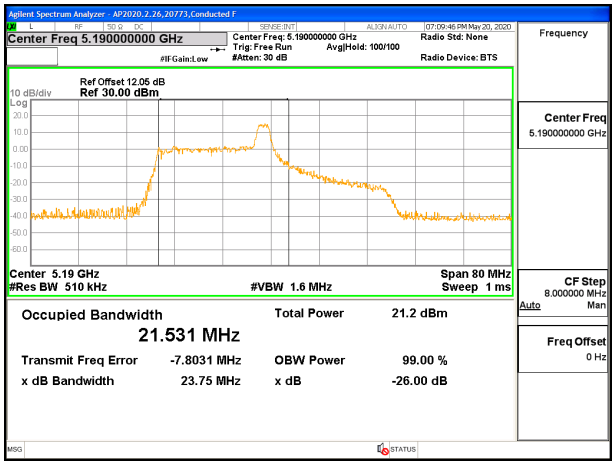
LOW CHANNEL [ANT 6]



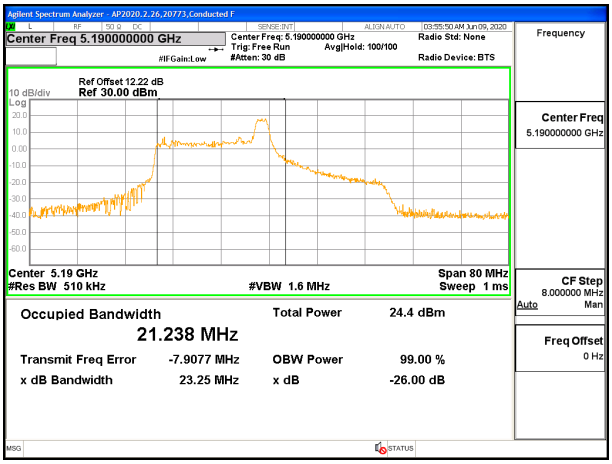
LOW CHANNEL [ANT 5]

2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 8

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5190	21.531	23.75	21.238	23.25
High	5230	21.452	23.57	21.236	23.30



LOW CHANNEL [ANT 6]



LOW CHANNEL [ANT 5]

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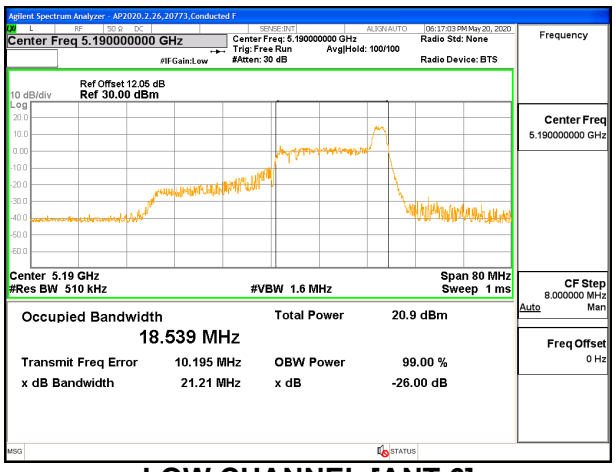
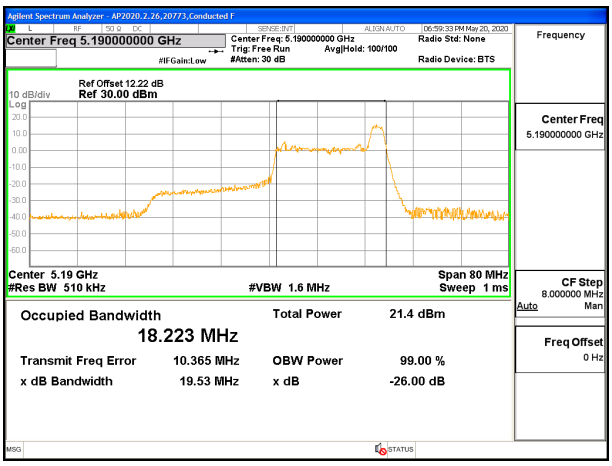
2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 17

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5190	18.539	21.21	18.223	19.53
High	5230	18.361	20.69	18.202	19.55



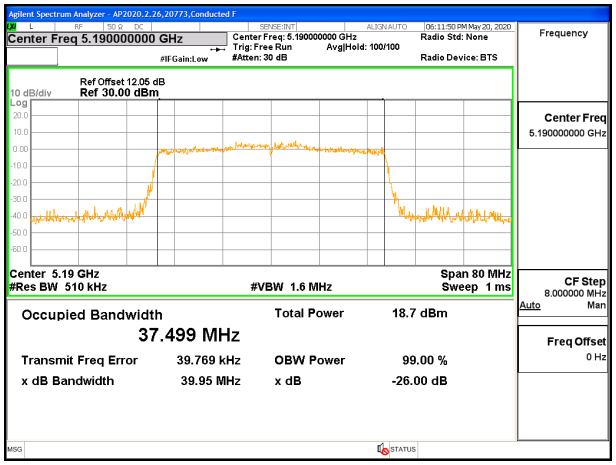
LOW CHANNEL [ANT 6]



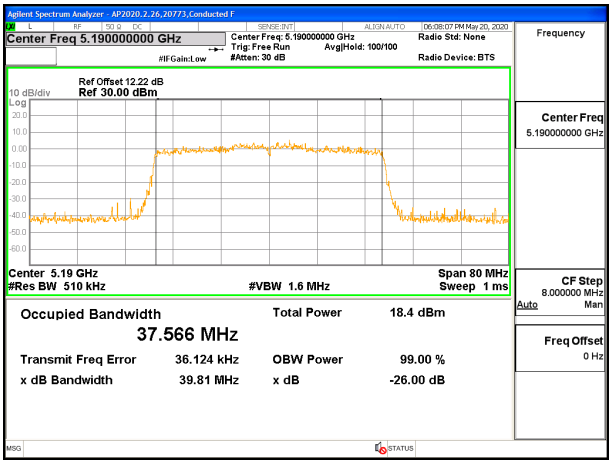
LOW CHANNEL [ANT 5]

2TX ANT 6 + ANT 5 OFDMA MODE: 484 Tones, RU Index 65

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Low	5190	37.499	39.95	37.566	39.81
High	5230	37.582	39.55	37.594	39.84



LOW CHANNEL [ANT 6]



LOW CHANNEL [ANT 5]

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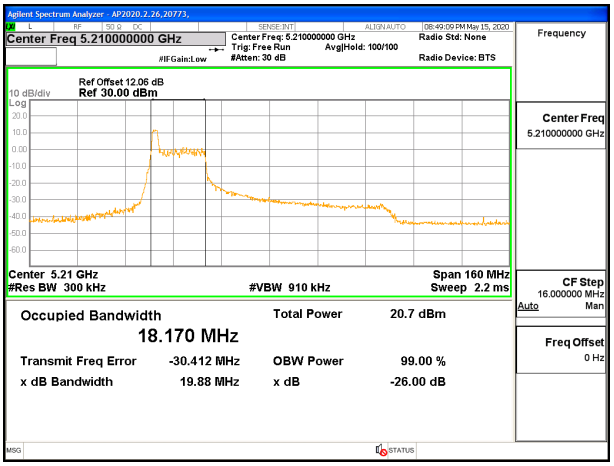
9.2.6. 802.11ax HE80 MODE IN THE 5.2 GHz BAND

1TX ANT 6 MODE: 26 Tones, RU Index 0

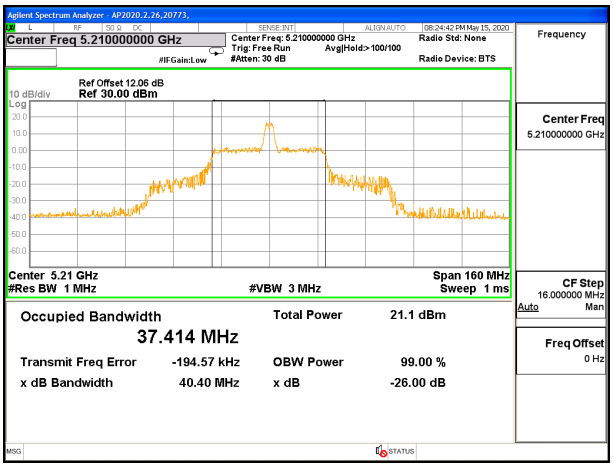
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	18.170	19.88



MID CHANNEL

1TX ANT 6 MODE: 26 Tones, RU Index 18

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	37.414	40.40



MID CHANNEL

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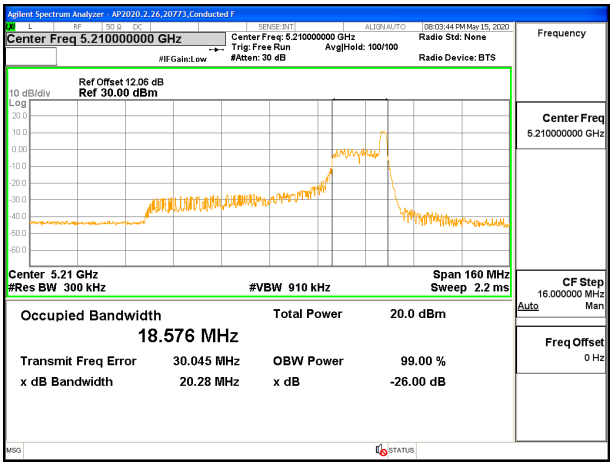
1TX ANT 6 MODE: 26 Tones, RU Index 36

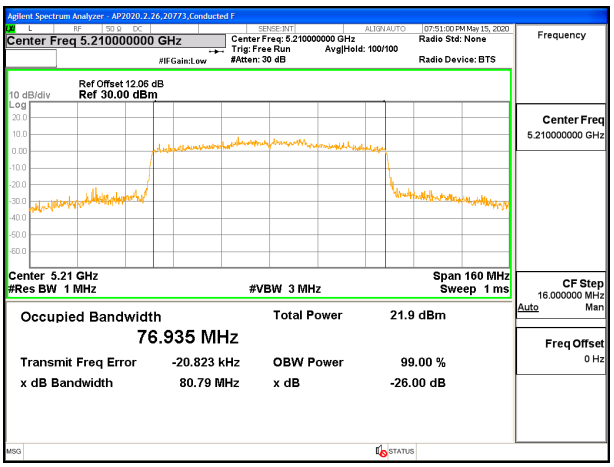
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	18.576	20.28



MID CHANNEL

1TX ANT 6 MODE: 996 Tones, RU Index 67

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	76.935	80.79



MID CHANNEL

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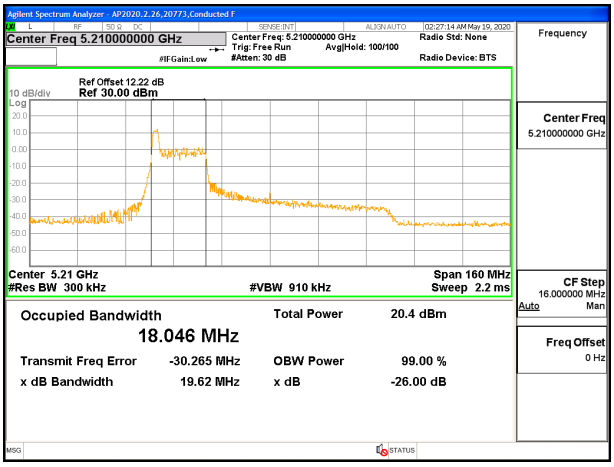
1TX ANT 5 MODE: 26 Tones, RU Index 0

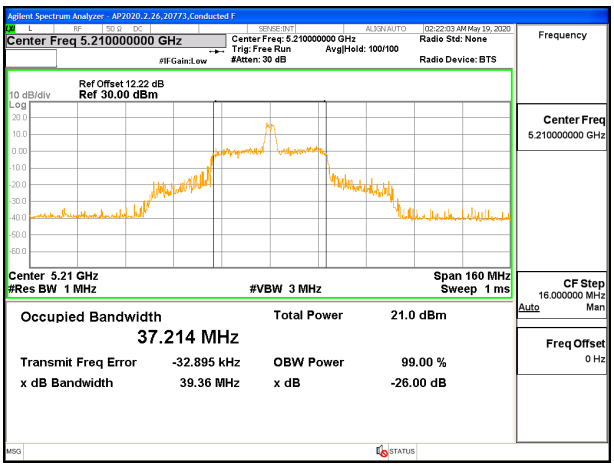
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	18.046	19.62



MID CHANNEL

1TX ANT 5 MODE: 26 Tones, RU Index 18

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	37.214	39.36



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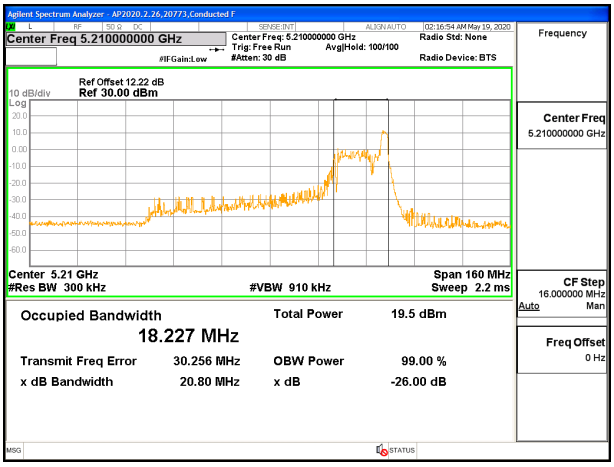
1TX ANT 5 MODE: 26 Tones, RU Index 36

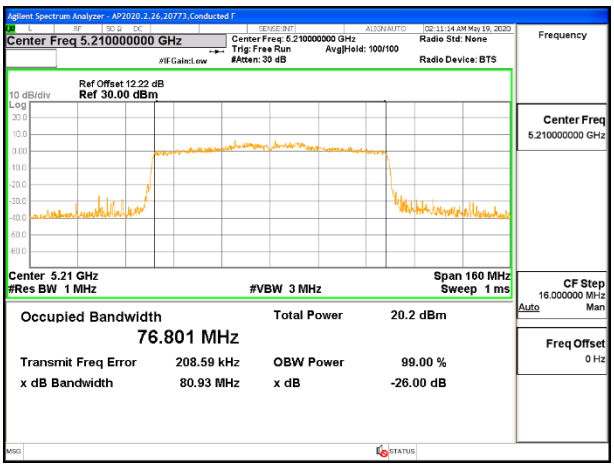
Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	18.227	20.80



MID CHANNEL

1TX ANT 5 MODE: 996 Tones, RU Index 67

Channel	Frequency (MHz)	99% Bandwidth (MHz)	26 dB Bandwidth (MHz)
Mid	5210	76.801	80.93



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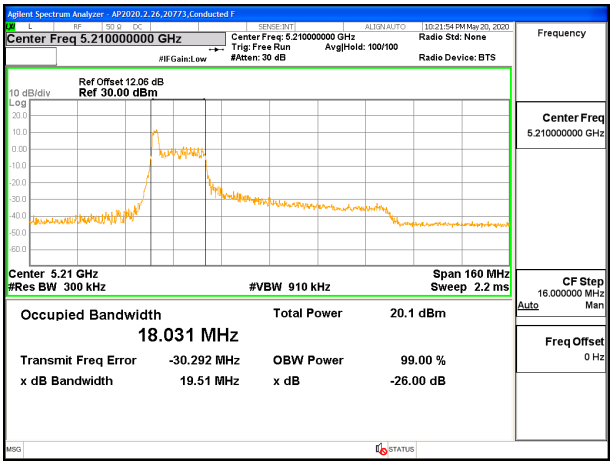
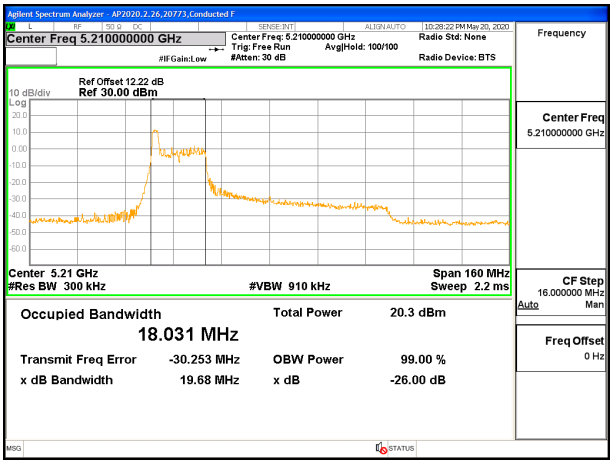
2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 0

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Mid	5210	18.031	19.51	18.031	19.68



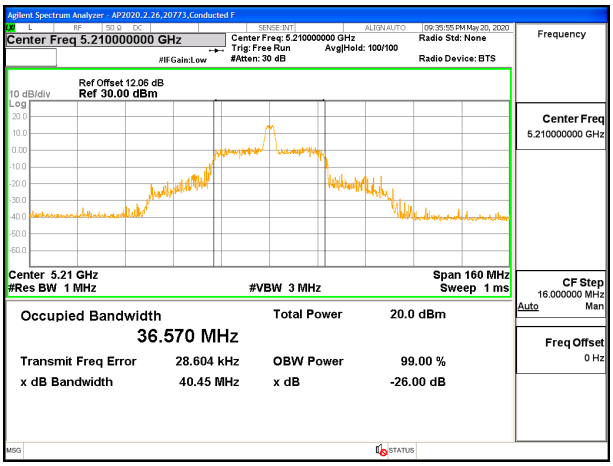
MID CHANNEL [ANT 6]



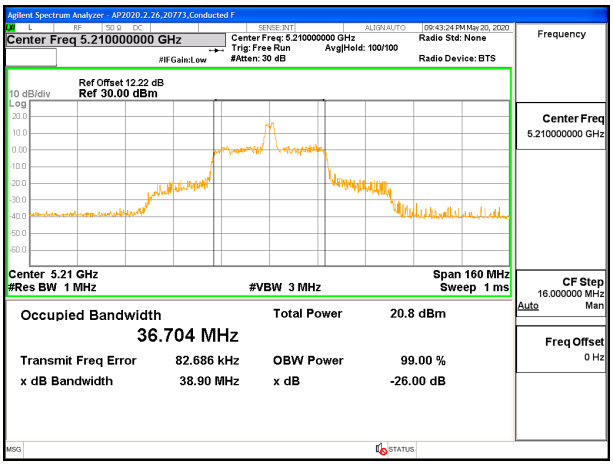
MID CHANNEL [ANT 5]

2TX ANT 6 + ANT 5 OFDMA MODE: 26 Tones, RU Index 18

Channel	Frequency (MHz)	99% Bandwidth ANT 6 (MHz)	26 dB Bandwidth ANT 6 (MHz)	99% Bandwidth ANT 5 (MHz)	26 dB Bandwidth ANT 5 (MHz)
Mid	5210	36.570	40.45	36.704	38.90



MID CHANNEL [ANT 6]



MID CHANNEL [ANT 5]

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