



# **TEST REPORT**

**Test Report No. : UL-RPT-RP12173937JD10A V2.0**

**Customer** : Apple Inc.  
**Model No.** : A1989  
**FCC ID** : BCGA1989  
**Technology** : WLAN  
**Test Standard(s)** : FCC Parts 15.209(a) & 15.407

**Test Laboratory** : UL VS LTD, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

**Date of Issue:** 27 June 2018

**Checked by:**

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**Report Revision History**

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	21/06/2018	Initial Version	Sarah Williams
2.0	27/06/2018	Admin update	Sarah Williams

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## **1. Attestation of Test Results**

### **1.1. Description of EUT**

The equipment under test was a Laptop Computer with WLAN and *Bluetooth*.

### **1.2. General Information**

<b>Specification Reference:</b>	47CFR15.407 and 47CFR15.403
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart E (Unlicensed National Information Infrastructure Devices) – Sections 15.403 and 15.407
<b>Specification Reference:</b>	47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
<b>Site Registration:</b>	209735
<b>Location of Testing:</b>	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	31 January 2018 to 29 May 2018

### 1.3. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.403(i)	Transmitter 26 dB Emission Bandwidth	Complied
Part 15.407(e)	Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band)	Complied
Part 15.407(e)	Transmitter Minimum 6 dB Bandwidth (Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz)	Complied
Part 15.407(a)(1)(iv)	Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band)	Complied
Part 15.407(a)(2)	Transmitter Maximum Conducted Output Power (5.25-5.35 GHz & 5.47-5.725 GHz bands)	Complied
Part 15.407(a)(2)	Transmitter Maximum Conducted Output Power (Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz)	Complied
Part 15.407(a)(3)	Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band)	Complied
Part 15.407(a)(1)(iv)	Transmitter Maximum Power Spectral Density (5.15-5.25 GHz band)	Complied
Part 15.407(a)(2)	Transmitter Maximum Power Spectral Density (5.25-5.35 GHz & 5.47-5.725 GHz bands)	Complied
Part 15.407(a)(2)	Transmitter Maximum Power Spectral Density (Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz)	Complied
Part 15.407(a)(3)	Transmitter Maximum Power Spectral Density (5.725-5.85 GHz band)	Complied
Part 15.407(b)/15.209(a)	Transmitter Out of Band Radiated Emissions	Complied
Part 15.407(b)/15.209(a)	Transmitter Band Edge Radiated Emissions	Complied
Part 15.407(g)	Transmitter Frequency Stability (Temperature & Voltage Variation)	Note 2
Part 15.407(h)(1)	Transmitter Power Control	Note 3

#### **Note(s):**

1. The measurement was performed to assist in the calculation of the level of average output power, power spectral density and emissions as the EUT employs pulsed operation.
2. Frequency stability is better than 20 ppm which ensures that the signal remains in the allocated bands under all operational conditions stated in the user manual.
3. Transmit Power Control was not tested as the maximum EIRP is less than 500 mW (27 dBm).

### 1.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specifications identified above.

## **2. Summary of Testing**

### **2.1. Facilities and Accreditation**

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	
Site 2	X
Site 17	X

UL VS LTD is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

### **2.2. Methods and Procedures**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	KDB 789033 D02 General U-NII Test Procedures New Rules v02r01 December 14, 2017
<b>Title:</b>	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices (Part 15, Subpart E)
<b>Reference:</b>	KDB662911 D01 Multiple Transmitter Output v02r01    October 31, 2013
<b>Title:</b>	Emissions Testing of Transmitter with Multiple Outputs in the Same Band

## **2.3. Calibration and Uncertainty**

### **Measuring Instrument Calibration**

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

### **Measurement Uncertainty**

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value measured (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

<b>Measurement Type</b>	<b>Range</b>	<b>Confidence Level (%)</b>	<b>Calculated Uncertainty</b>
Duty Cycle	5.15 GHz to 5.850 GHz	95%	±1.14 %
26 dB Emission Bandwidth	5.15 GHz to 5.850 GHz	95%	±4.59 %
Minimum 6 dB Emission Bandwidth	5.15 GHz to 5.850 GHz	95%	±4.59 %
Maximum Conducted Output Power	5.15 GHz to 5.850 GHz	95%	±1.13 dB
Maximum Power Spectral Density	5.15 GHz to 5.850 GHz	95%	±1.13 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±4.65 dB
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	±2.94 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.



## 2.4. Test and Measurement Equipment

### Test Equipment Used for Transmitter Conducted Tests (non-TxBF)

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2004	Thermohygrometer	Testo	608-H1	45046425	26 Feb 2019	12
M2018	Signal Analyser	Rohde & Schwarz	FSV7	102699	23 Jun 2018	12
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	10 May 2019	36
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
A3028	Attenuator	Broadwave Technologies	351-311-006	#2	Calibrated before use	-
A3029	Attenuator	Broadwave Technologies	351-311-006	#3	Calibrated before use	-
A3030	Attenuator	Broadwave Technologies	351-311-006	#4	Calibrated before use	-

### Test Equipment Used for Transmitter Conducted Tests (TxBF)

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2001	Thermohygrometer	Testo	608-H1	45041824	28 Feb 2019	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	13 Jun 2018	12
G0615	Signal Generator	Rohde & Schwarz	SMBV100A	260473	08 May 2020	36
A2952	RF Switch	Pickering	64-102-002	XZ361012	Calibrated before use	-
A2505	Directional Coupler	AtlanTecRF	CDC-003060-20	1101230	Calibrated before use	-
A2534	Directional Coupler	AtlanTecRF	CDC-003060-20	14041701718	Calibrated before use	-
A2536	Directional Coupler	AtlanTecRF	CDC-003060-20	14041701720	Calibrated before use	-
A2097	Power splitter	Mini Circuits	ZN4PD1-63W-S+	SUU98701205	Calibrated before use	-
A2098	Power splitter	Mini Circuits	ZN4PD1-63-S+	SF210501205	Calibrated before use	-

**Test and Measurement Equipment (continued)****Test Equipment Used for Transmitter Radiated Emissions**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	27 Feb 2019	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	20 Feb 2019	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	18 Apr 2019	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	20 Feb 2019	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	21 Feb 2019	12
A2891	Pre Amplifier	Schwarzbeck	BBV 9718	9718-306	20 Feb 2019	12
A2893	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-021	26 Apr 2019	12
A2863	Pre Amplifier	Hewlett Packard	8449B	3008A02100	19 Feb 2019	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	19 Feb 2019	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	07 Feb 2019	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	20 Apr 2019	12
A1818	Antenna	EMCO	3115	00075692	07 Feb 2019	12
A253	Antenna	Flann Microwave	12240-20	128	07 Feb 2019	12
A254	Antenna	Flann Microwave	14240-20	139	07 Feb 2019	12
A255	Antenna	Flann Microwave	16240-20	519	07 Feb 2019	12
A256	Antenna	Flann Microwave	18240-20	400	07 Feb 2019	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	22 Feb 2019	12
A2176	High Pass Filter	AtlanTecRF	AFH-07000	800980	21 Feb 2019	12
A2133	Low Pass Filter	AtlanTecRF	AFL-04000	JFB1006-002	21 Feb 2019	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	21 Feb 2019	12

**Test Equipment Used for Transmitter Band Edge Radiated Emissions**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	27 Feb 2019	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	20 Feb 2019	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	18 Apr 2019	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	19 Feb 2019	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	19 Feb 2019	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	21 Feb 2019	12

### **3. Equipment Under Test (EUT)**

#### **3.1. Identification of Equipment Under Test (EUT)**

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02VR00RJH93 ( <i>Radiated sample #1</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>FCC ID:</b>	BCGA1989

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02W6011JTF2 ( <i>Radiated sample #2</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>FCC ID:</b>	BCGA1989

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02VQ00GJKHY ( <i>Radiated sample #3</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>FCC ID:</b>	BCGA1989

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02W6002JTDV ( <i>Radiated sample #4</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>FCC ID:</b>	BCGA1989

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02VQ00SJKHY ( <i>Conducted Sample #1</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>FCC ID:</b>	BCGA1989

**Identification of Equipment Under Test (EUT) (continued)**

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1989
<b>Test Sample Serial Number:</b>	C02W6002JTF0 ( <i>Conducted Sample #2</i> )
<b>Hardware Version:</b>	EVT
<b>Software Version:</b>	17G2014
<b>FCC ID:</b>	BCGA1989

**3.2. Modifications Incorporated in the EUT**

No modifications were applied to the EUT during testing.

**3.3. Additional Information Related to Testing**

<b>Technology Tested:</b>	WLAN (IEEE 802.11a,n,ac) / U-NII	
<b>Type of Unit:</b>	Transceiver	
<b>Modulation:</b>	BPSK, QPSK, 16QAM, 64QAM & 256QAM	
<b>Data rates:</b>	802.11a	6, 9, 12, 18, 24, 36, 48 & 54 Mbit/s (SISO, or MIMO with CDD)
	802.11n HT20	MCS0 to MCS7 (1 spatial stream), (SISO, or MIMO with CDD/STBC) w/ or w/o TxBF MCS8 to MCS15 (2 spatial streams) (MIMO SDM) w/ or w/o TxBF MCS16 to MCS23 (3 spatial streams) (MIMO SDM) w/ or w/o TxBF
	802.11n HT40	MCS0 to MCS7 (1 spatial stream), (SISO, or MIMO with CDD/STBC) w/ or w/o TxBF MCS8 to MCS15 (2 spatial streams) (MIMO SDM) w/ or w/o TxBF MCS16 to MCS23 (3 spatial streams) (MIMO SDM) w/ or w/o TxBF
	802.11ac VHT20	MCS0 to MCS8 (1, 2 or 3 spatial streams) (SISO, or MIMO with CDD/STBC/SDM) w/ or w/o TxBF
	802.11ac VHT40	MCS0 to MCS9 (1, 2 or 3 spatial streams) (SISO, or MIMO with CDD/STBC/SDM) w/ or w/o TxBF
	802.11ac VHT80	MCS0 to MCS9 (1, 2 or 3 spatial streams) (SISO, or MIMO with CDD/STBC/SDM) w/ or w/o TxBF
<b>Power Supply Requirement(s):</b>	Nominal	3.8 VDC via 120 VAC 60 Hz AC/DC adapter
<b>Maximum Conducted Output Power:</b>	20 MHz	25.6 dBm
	40 MHz	25.0 dBm
	80 MHz	22.5 dBm

**Additional Information Related to Testing (continued)**

<b>Channel Spacing:</b>	20 MHz		
<b>Transmit Frequency Band:</b>	5150 MHz to 5250 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	36	5180
	Middle	40	5200
	Top	48	5240
<b>Transmit Frequency Band:</b>	5250 MHz to 5350 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	52	5260
	Middle	56	5280
	Top	64	5320
<b>Transmit Frequency Band:</b>	5470 MHz to 5725 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	100	5500
	Middle	116	5580
	Top	140	5700
<b>Transmit Frequency Band:</b>	Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz		
<b>Transmit Channel Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Single	144	5720
<b>Transmit Frequency Band:</b>	5725 MHz to 5850 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	149	5745
	Middle	157	5785
	Top	165	5825

**Additional Information Related to Testing (continued)**

<b>Channel Spacing:</b>	40 MHz		
<b>Transmit Frequency Band:</b>	5150 MHz to 5250 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	38	5190
	Top	46	5230
<b>Transmit Frequency Band:</b>	5250 MHz to 5350 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	54	5270
	Top	62	5310
<b>Transmit Frequency Band:</b>	5470 MHz to 5725 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	102	5510
	Middle	118	5590
	Top	134	5670
<b>Transmit Frequency Band:</b>	Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz		
<b>Transmit Channel Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Single	142	5710
<b>Transmit Frequency Band:</b>	5725 MHz to 5850 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	151	5755
	Top	159	5795

**Additional Information Related to Testing (continued)**

<b>Channel Spacing:</b>	80 MHz		
<b>Transmit Frequency Band:</b>	5150 MHz to 5250 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Single	42	5210
<b>Transmit Frequency Band:</b>	5250 MHz to 5350 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Single	58	5290
<b>Transmit Frequency Band:</b>	5470 MHz to 5725 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Bottom	106	5530
	Top	122	5610
<b>Transmit Frequency Band:</b>	Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz		
<b>Transmit Channel Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Single	138	5690
<b>Transmit Frequency Band:</b>	5725 MHz to 5850 MHz		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	Single	155	5775



### 3.4. Description of Available Antennas

The radio utilizes three integrated antennas, with the following maximum gains:

Frequency Band (MHz)	G <sub>Antenna WF1</sub> (dBi)	G <sub>Antenna WF2</sub> (dBi)	G <sub>Antenna WF3</sub> (dBi)
5150 to 5250	5.7	5.3	5.5
5250 to 5350	6.5	6.0	6.3
5470 to 5725	5.1	5.2	5.0
5725 to 5850	4.6	5.2	4.5

#### Directional Antenna Gain for Correlated Signals (CDD) / Output Power Measurements:

Frequency Band (MHz)	G <sub>Antennas WF1, WF3</sub> (dBi)	G <sub>Antennas WF1, WF2</sub> (dBi)	G <sub>Antennas WF1, WF2, WF3</sub> (dBi)
5150 to 5250	5.7	-	5.7
5250 to 5350	6.5	-	6.5
5470 to 5725	-	5.2	5.2
5725 to 5850	-	5.2	5.2

#### Directional Antenna Gain for Correlated Signals (CDD) / PSD Measurements:

Frequency Band (MHz)	G <sub>Antennas WF1, WF3</sub> (dBi)	G <sub>Antennas WF1, WF2</sub> (dBi)	G <sub>Antennas WF1, WF2, WF3</sub> (dBi)
5150 to 5250	8.6	-	10.3
5250 to 5350	9.4	-	11.0
5470 to 5725	-	8.2	9.9
5725 to 5850	-	7.9	9.5

#### Directional Antenna Gain for Uncorrelated Signals (STBC):

Frequency Band (MHz)	G <sub>Antennas WF1, WF3</sub> (dBi)	G <sub>Antennas WF1, WF2</sub> (dBi)	G <sub>Antennas WF1, WF2, WF3</sub> (dBi)
5150 to 5250	5.6	-	5.5
5250 to 5350	6.4	-	6.3
5470 to 5725	-	5.2	5.1
5725 to 5850	-	4.9	4.8

#### Directional Antenna Gain for Correlated Signals (TxBF):

Frequency Band (MHz)	G <sub>Antennas WF1, WF3</sub> (dBi)	G <sub>Antennas WF1, WF2</sub> (dBi)	G <sub>Antennas WF1, WF2, WF3</sub> (dBi)
5150 to 5250	8.6	-	10.3
5250 to 5350	9.4	-	11.0
5470 to 5725	-	8.2	9.9
5725 to 5850	-	7.9	9.5

Refer to Appendix 1 of this test report for directional antenna gain calculations.

### **3.5. Description of Test Setup**

#### **Support Equipment**

The following support equipment was used to exercise the EUT during testing:

<b>Brand Name:</b>	Not marked or stated
<b>Description:</b>	Type C USB Cable. Length 2.0 metres
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Brand Name:</b>	Apple
<b>Description:</b>	USB-C Power Adapter
<b>Model Name or Number:</b>	A1947
<b>Serial Number:</b>	Not marked or stated

<b>Brand Name:</b>	Belkin
<b>Description:</b>	USB-C Adapter
<b>Model Name or Number:</b>	F2CU040
<b>Serial Number:</b>	Not marked or stated

<b>Brand Name:</b>	Apple
<b>Description:</b>	USB-C Power Adapter
<b>Model Name or Number:</b>	A1718
<b>Serial Number:</b>	Not marked or stated

<b>Brand Name:</b>	Apple
<b>Description:</b>	PHF (Personal Hands Free)
<b>Model Name or Number:</b>	Apple EarPods
<b>Serial Number:</b>	Not marked or stated

<b>Brand Name:</b>	Not marked or stated
<b>Description:</b>	Type A USB Cable. Length 3.0 metres
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Brand Name:</b>	Belkin
<b>Description:</b>	4 Port USB Hub
<b>Model Name or Number:</b>	F5U404-BLK
<b>Serial Number:</b>	Not marked or stated

**Support Equipment (continued)**

<b>Brand Name:</b>	Apple
<b>Description:</b>	Support Laptop (Conducted beamforming tests)
<b>Model Name or Number:</b>	MacBook
<b>Serial Number:</b>	C02S400GH7C5

<b>Brand Name:</b>	Apple
<b>Description:</b>	Support Laptop (Radiated beamforming tests)
<b>Model Name or Number:</b>	MacBook
<b>Serial Number:</b>	C02S3008H7CF

## **Operating Modes**

The EUT was tested in the following operating mode(s):

- Continuously transmitting with a modulated carrier at maximum power on the bottom, middle and top channels as required using the supported data rates/modulation types.

## **Configuration and Peripherals**

The EUT was tested in the following configuration(s):

- Controlled in test mode using a software application on the EUT supplied by the customer. The application was used to enable a continuous transmission and to select the test channels as required. The customer supplied scripts 'EUT\_EVT\_wlan\_setup\_v1.sh' to control the EUT.
- For TxBF modes, the EUT was communicating via a conducted RF link with an equivalent device. The EUT ran iPerf bandwidth testing application in client mode to produce maximum throughput. The customer supplied a document containing the setup instructions 'EUT\_TXBF\_operating\_procedures\_v1.5.pdf'.
- For TxBF modes, the EUT was communicating via a radiated RF link with an equivalent device. The EUT ran iPerf bandwidth testing application in client mode to produce maximum throughput. The customer supplied a document containing the setup instructions 'EUT\_TXBF\_operating\_procedures\_v1.4.pdf'.

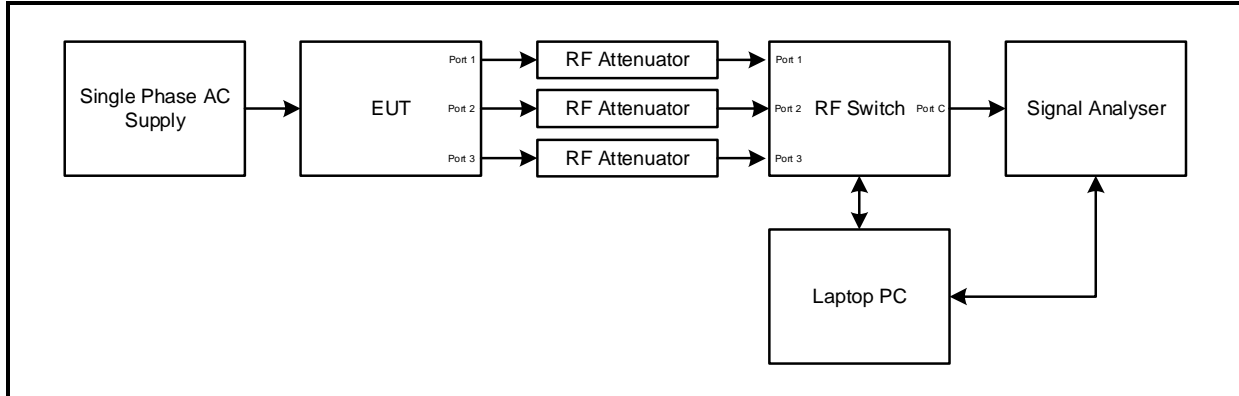
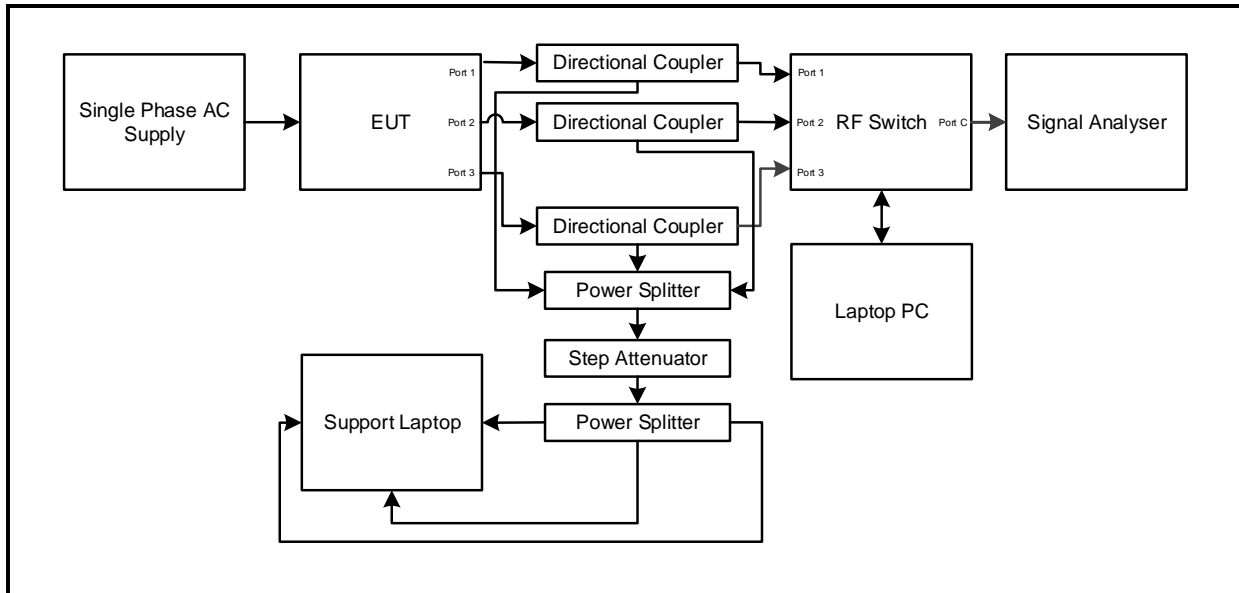
- The customer requested the following data rates to be used for all measurements:

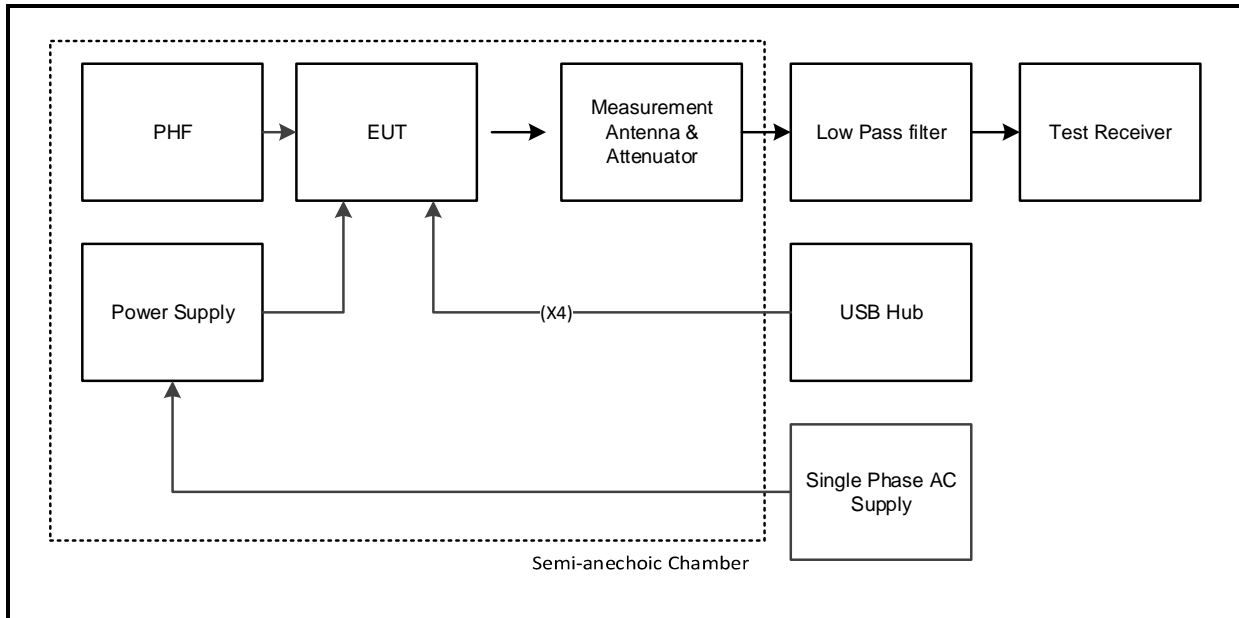
On frequency bands 5150-5250 MHz and 5250-5350 MHz:

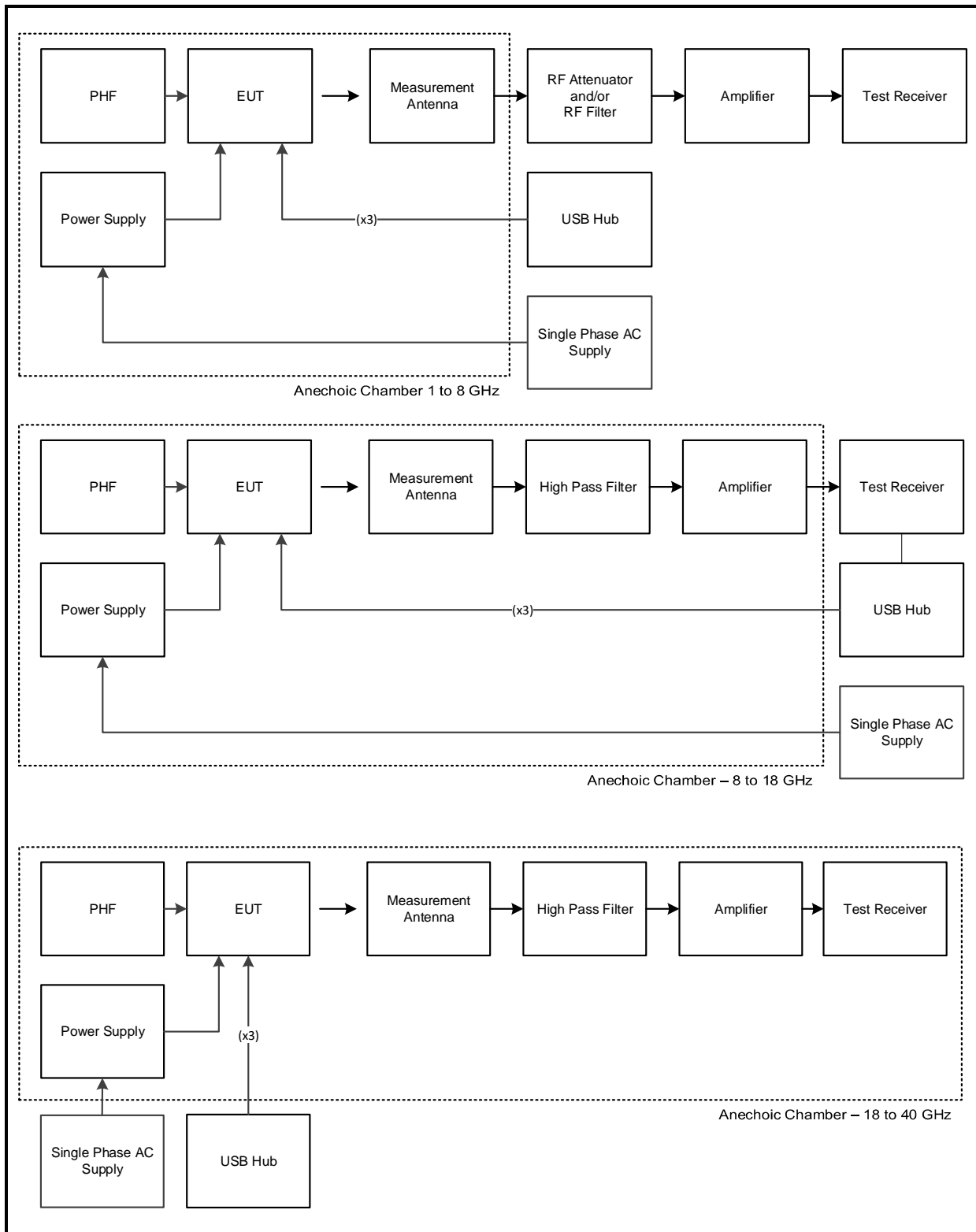
- 802.11a SISO - BPSK / 6 Mbps / Port WF1
- 802.11n HT20 / SISO – BPSK / MCS0 / Port WF1
- 802.11n HT40 / SISO – BPSK / MCS0 / Port WF1
- 802.11ac VHT80 / SISO – BPSK / MCS0 / Port WF1
- 802.11n HT20 / MIMO / 2Tx CDD – BPSK / MCS0 / Ports WF1 & WF3
- 802.11n HT40 / MIMO / 2Tx CDD – BPSK / MCS0 / Ports WF1 & WF3
- 802.11ac VHT80 / MIMO / 2Tx CDD – BPSK / MCS0x1 / Ports WF1 & WF3
- 802.11n HT20 / MIMO / 2Tx STBC – BPSK / MCS0 / Ports WF1 & WF3
- 802.11n HT40 / MIMO / 2Tx STBC – BPSK / MCS0 / Ports WF1 & WF3
- 802.11ac VHT80 / MIMO / 2Tx STBC – BPSK / MCS0x1 / Ports WF1 & WF3
- 802.11n HT20 / MIMO / 2Tx TxBF – BPSK / MCS0 / Ports WF1 & WF3
- 802.11n HT40 / MIMO / 2Tx TxBF – BPSK / MCS0 / Ports WF1 & WF3
- 802.11ac VHT80 / MIMO / 2Tx TxBF – BPSK / MCS0x1 / Ports WF1 & WF3
- 802.11n HT20 / MIMO / 3Tx CDD – BPSK / MCS0 / Ports WF1, WF2 & WF3
- 802.11n HT40 / MIMO / 3Tx CDD – BPSK / MCS0 / Ports WF1, WF2 & WF3
- 802.11ac VHT80 / MIMO / 3Tx CDD – BPSK / MCS0x1 / Ports WF1, WF2 & WF3
- 802.11n HT20 / MIMO / 3Tx STBC – BPSK / MCS0 / Ports WF1, WF2 & WF3
- 802.11n HT40 / MIMO / 3Tx STBC – BPSK / MCS0 / Ports WF1, WF2 & WF3
- 802.11ac VHT80 / MIMO / 3Tx STBC – BPSK / MCS0x1 / Ports WF1, WF2 & WF3
- 802.11n HT20 / MIMO / 3Tx TxBF – BPSK / MCS0 / Ports WF1, WF2 & WF3
- 802.11n HT40 / MIMO / 3Tx TxBF – BPSK / MCS0 / Ports WF1, WF2 & WF3
- 802.11ac VHT80 / MIMO / 3Tx TxBF – BPSK / MCS0x1 / Ports WF1, WF2 & WF3

**Configuration and Peripherals (continued)**

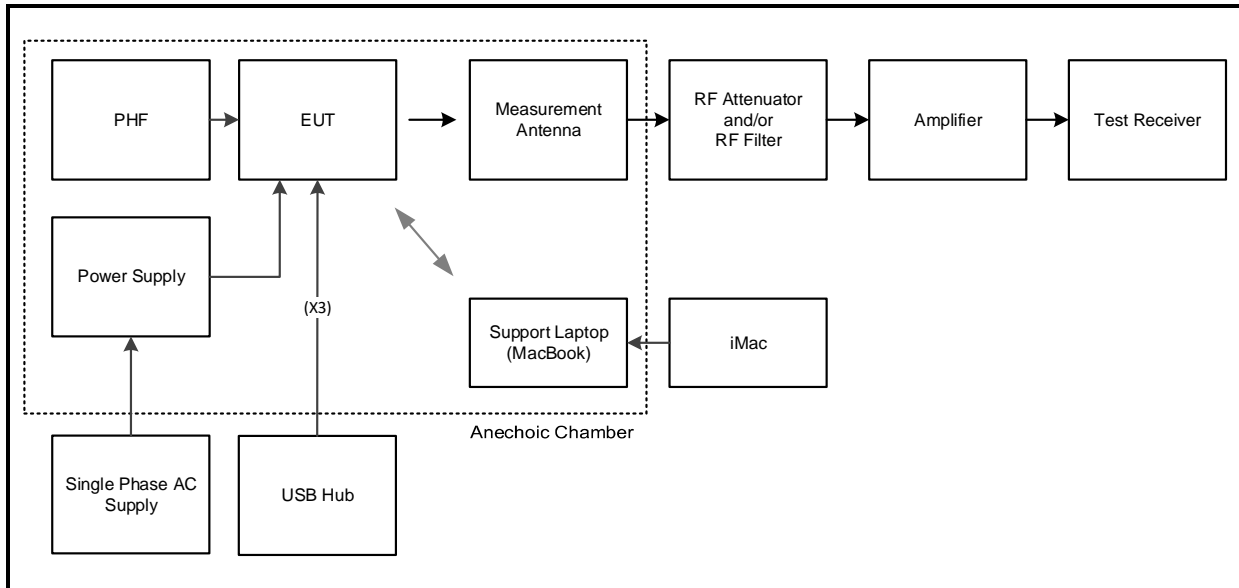
- The customer requested the following data rates to be used for all measurements:  
On frequency bands 5470-5725 MHz and 5725-5850 MHz:
  - 802.11a SISO - BPSK / 6 Mbps / Port WF2
  - 802.11n HT20 / SISO – BPSK / MCS0 / Port WF2
  - 802.11n HT40 / SISO – BPSK / MCS0 / Port WF2
  - 802.11ac VHT80 / SISO – BPSK / MCS0 / Port WF2
  - 802.11n HT20 / MIMO / 2Tx CDD – BPSK / MCS0 / Ports WF1 & WF2
  - 802.11n HT40 / MIMO / 2Tx CDD – BPSK / MCS0 / Ports WF1 & WF2
  - 802.11ac VHT80 / MIMO / 2Tx CDD – BPSK / MCS0x1 / Ports WF1 & WF3
  - 802.11n HT20 / MIMO / 2Tx STBC – BPSK / MCS0 / Ports WF1 & WF2
  - 802.11n HT40 / MIMO / 2Tx STBC – BPSK / MCS0 / Ports WF1 & WF2
  - 802.11ac VHT80 / MIMO / 2Tx STBC – BPSK / MCS0x1 / Ports WF1 & WF3
  - 802.11n HT20 / MIMO / 2Tx TxBF – BPSK / MCS0 / Ports WF1 & WF2
  - 802.11n HT40 / MIMO / 2Tx TxBF – BPSK / MCS0 / Ports WF1 & WF2
  - 802.11ac VHT80 / MIMO / 2Tx TxBF – BPSK / MCS0x1 / Ports WF1 & WF3
  - 802.11n HT20 / MIMO / 3Tx CDD – BPSK / MCS0 / Ports WF1, WF2 & WF3
  - 802.11n HT40 / MIMO / 3Tx CDD – BPSK / MCS0 / Ports WF1, WF2 & WF3
  - 802.11ac VHT80 / MIMO / 3Tx CDD – BPSK / MCS0x1 / Ports WF1, WF2 & WF3
  - 802.11n HT20 / MIMO / 3Tx STBC – BPSK / MCS0 / Ports WF1, WF2 & WF3
  - 802.11n HT40 / MIMO / 3Tx STBC – BPSK / MCS0 / Ports WF1, WF2 & WF3
  - 802.11ac VHT80 / MIMO / 3Tx STBC – BPSK / MCS0x1 / Ports WF1, WF2 & WF3
  - 802.11n HT20 / MIMO / 3Tx TxBF – BPSK / MCS0 / Ports WF1, WF2 & WF3
  - 802.11n HT40 / MIMO / 3Tx TxBF – BPSK / MCS0 / Ports WF1, WF2 & WF3
  - 802.11ac VHT80 / MIMO / 3Tx TxBF – BPSK / MCS0x1 / Ports WF1, WF2 & WF3
- The EUT has three separate antennas which correspond to three separate antenna ports. Port WF1, Port WF2 and Port WF3 correspond to antenna 2, antenna 1 and antenna 3 respectively.
- The customer supplied U.FL RF cables with the EUT in order to perform conducted measurements. The measured additional path loss was included in any path loss calculations.
- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of 802.11n HT20 / MCS0 / MIMO 3Tx CDD.
- Transmitter radiated spurious emissions tests were performed with the AC Charger and PHF connected to the EUT. The USB ports were terminated to a USB hub which was placed outside the chamber.
- The EUT was powered from a 120 VAC 60 Hz single phase mains supply.

**Test Setup Diagrams****Conducted Tests:****Test Setup for Transmitter Conducted Tests (non TxBF)****Test Setup for Transmitter Conducted Tests (TxBF)**

**Radiated Tests:****Test Setup for Transmitter Radiated Emissions (non TxBF)**

**Test Setup Diagrams (continued)****Test Setup for Transmitter Radiated Emissions (continued)**



**Test Setup Diagrams (continued)****Radiated Tests (continued): Test Setup for Transmitter Radiated Emissions (TXBF)**

## 4. Antenna Port Test Results

### 4.1. Transmitter Duty Cycle

#### Test Summary:

Test Engineers:	Max Passell & Andrew Edwards	Test Dates:	23 April 2018 to 22 May 2018
Test Sample Serial Numbers:	C02VQ00SJKHY & C02W6002JTF0		

FCC Reference:	Part 15.35(c)
Test Method Used:	KDB 789033 D02 Section II.B.2.b)

#### Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	42 to 58

#### Note(s):

- In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

$$10 \log 1 / (\text{On Time} / [\text{Period or } 100\text{ms whichever is the lesser}]).$$

$$802.11n \text{ HT40} / \text{SISO} / \text{MCS0 duty cycle: } 10 \log (1 / (0.9363/0.9604)) = 0.1$$

$$802.11ac \text{ VHT80} / \text{SISO} / \text{MCS0x1 duty cycle: } 10 \log (1 / (0.4587/0.4822)) = 0.2$$

$$802.11n \text{ HT40} / \text{MIMO} / 2\text{TxD} / \text{MCS0 duty cycle: } 10 \log (1 / (0.9363/0.9604)) = 0.1$$

$$802.11ac \text{ VHT80} / \text{MIMO} / 2\text{TxD} / \text{MCS0x1 duty cycle: } 10 \log (1 / (0.4590/0.4812)) = 0.2$$

$$802.11n \text{ HT40} / \text{MIMO} / 2\text{TxD} / \text{MCS0 duty cycle: } 10 \log (1 / (0.9501/0.9732)) = 0.1$$

$$802.11ac \text{ VHT80} / \text{MIMO} / 2\text{TxD} / \text{MCS0x1 duty cycle: } 10 \log (1 / (0.4612/0.4831)) = 0.2$$

$$802.11n \text{ HT40} / \text{MIMO} / 2\text{TxD} / \text{MCS0 duty cycle: } 10 \log (1 / (5.300/5.560)) = 0.2$$

$$802.11ac \text{ VHT80} / \text{MIMO} / 2\text{TxD} / \text{MCS0x1 duty cycle: } 10 \log (1 / (3.672/3.750)) = 0.1$$

$$802.11n \text{ HT40} / \text{MIMO} / 3\text{TxD} / \text{MCS0 duty cycle: } 10 \log (1 / (0.9363/0.9604)) = 0.1$$

$$802.11ac \text{ VHT80} / \text{MIMO} / 3\text{TxD} / \text{MCS0 duty cycle: } 10 \log (1 / (0.4593/0.4822)) = 0.2$$

$$802.11n \text{ HT40} / \text{MIMO} / 3\text{TxD} / \text{MCS0 duty cycle: } 10 \log (1 / (0.9501/0.9732)) = 0.1$$

$$802.11ac \text{ VHT80} / \text{MIMO} / 3\text{TxD} / \text{MCS0 duty cycle: } 10 \log (1 / (0.4688/0.4902)) = 0.2$$

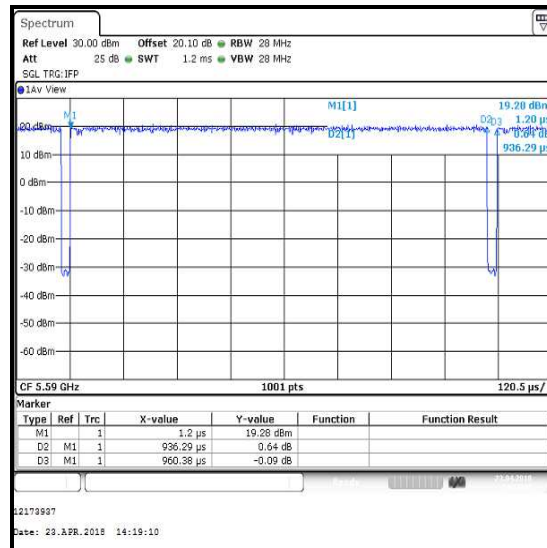
$$802.11n \text{ HT40} / \text{MIMO} / 3\text{TxD} / \text{MCS0x1 duty cycle: } 10 \log (1 / (5.320/5.590)) = 0.2$$

$$802.11ac \text{ VHT80} / \text{MIMO} / 3\text{TxD} / \text{MCS0x1 duty cycle: } 10 \log (1 / (3.829/3.955)) = 0.1$$

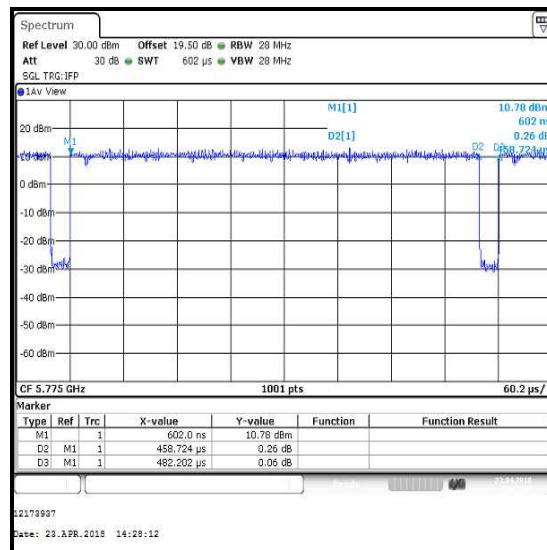
- Measurements were performed on all EUT ports and found to be identical. Therefore only results for port WF2 are presented in the section of the test report.
- Plots below are for data rates with a duty cycle less than 98%. Results for all other modes having a duty cycle >98% are archived on the UL VS LTD IT server and available for inspection if required.
- The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
- The EUT with serial number C02VQ00SJKHY was used for non-Tx BF tests, the EUT with serial number C02W6002JTF0 was used for Tx BF tests.

**Transmitter Duty Cycle (continued)****Results: 802.11n / 40 MHz / SISO / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.9363	0.9604	0.1

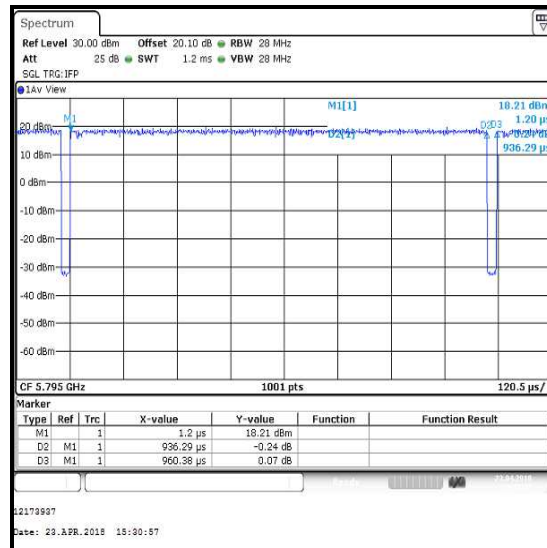
**Results: 802.11ac / 80 MHz / SISO / MCS0x1**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.4587	0.4822	0.2

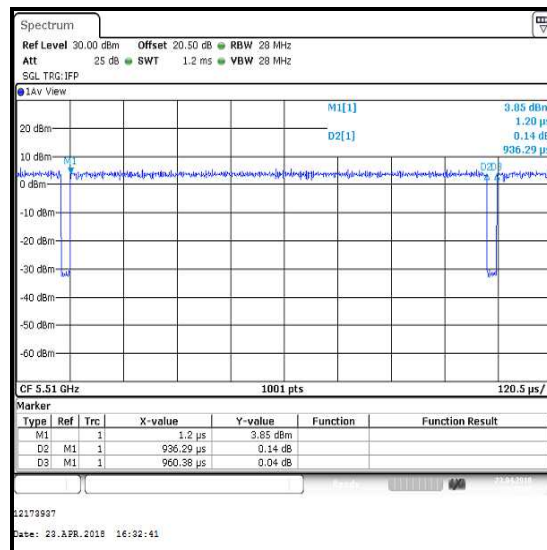


**Transmitter Duty Cycle (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx CDD / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.9363	0.9604	0.1

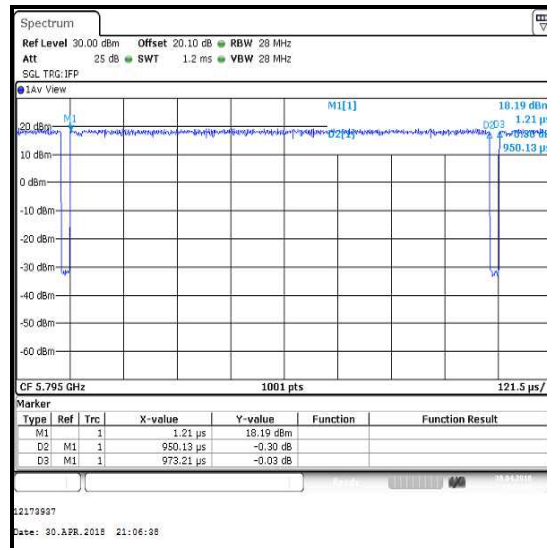
**Results: 802.11n / 40 MHz / MIMO / 3Tx CDD / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.9363	0.9604	0.1

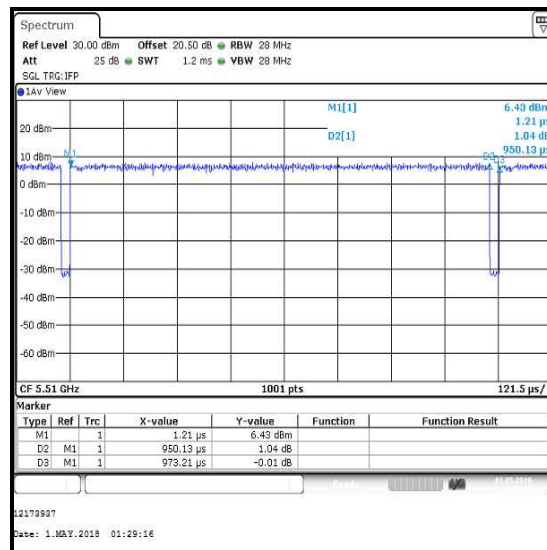


**Transmitter Duty Cycle (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx STBC / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.9501	0.9732	0.1

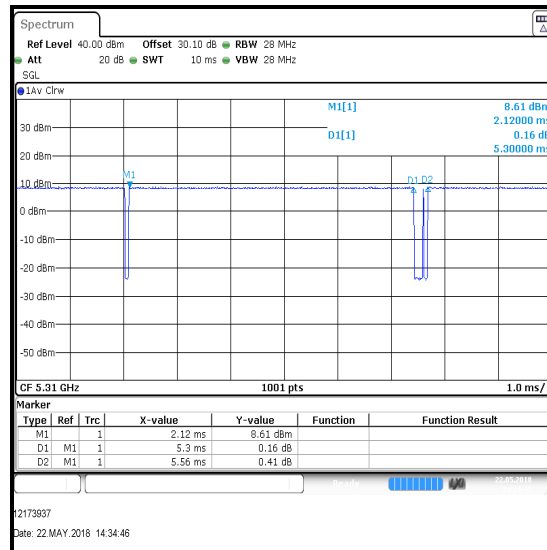
**Results: 802.11n / 40 MHz / MIMO / 3Tx STBC / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.9501	0.9732	0.1

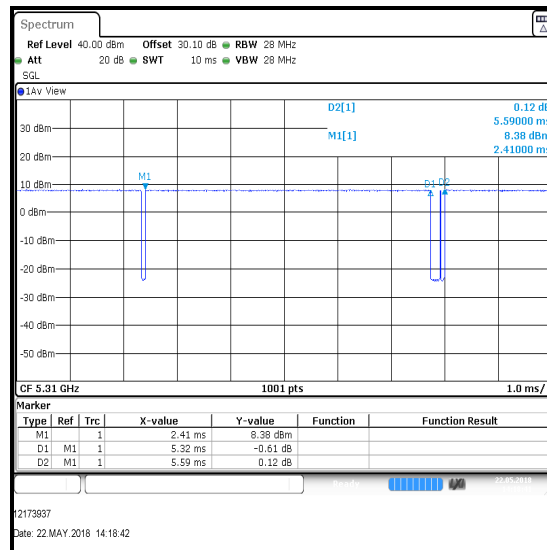


**Transmitter Duty Cycle (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx TxBF / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
5.300	5.560	0.2

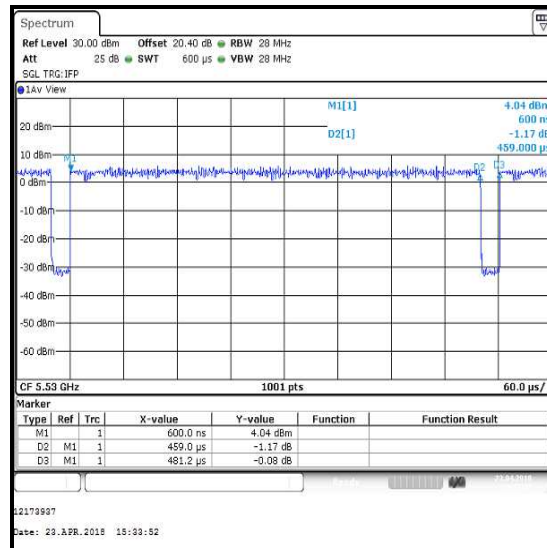
**Results: 802.11n / 40 MHz / MIMO / 3Tx TxBF / MCS0**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
5.320	5.590	0.2

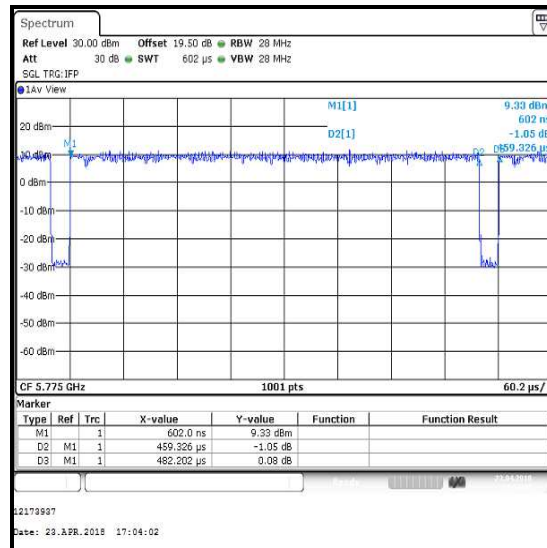


**Transmitter Duty Cycle (continued)****Results: 802.11ac / 80 MHz / MIMO / 2Tx CDD / MCS0x1**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.4590	0.4812	0.2

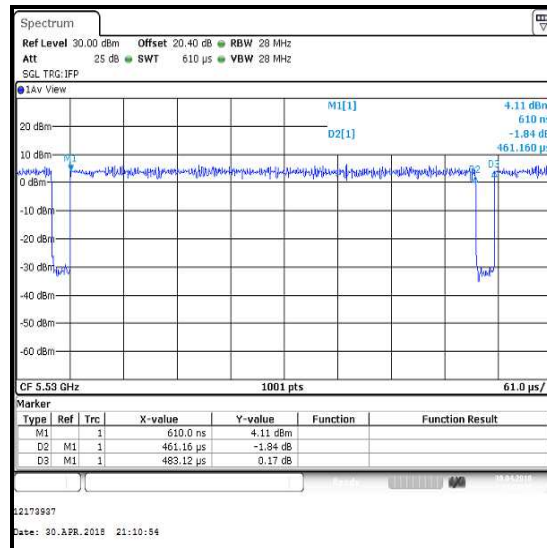
**Results: 802.11ac / 80 MHz / MIMO / 3Tx CDD / MCS0x1**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.4593	0.4822	0.2

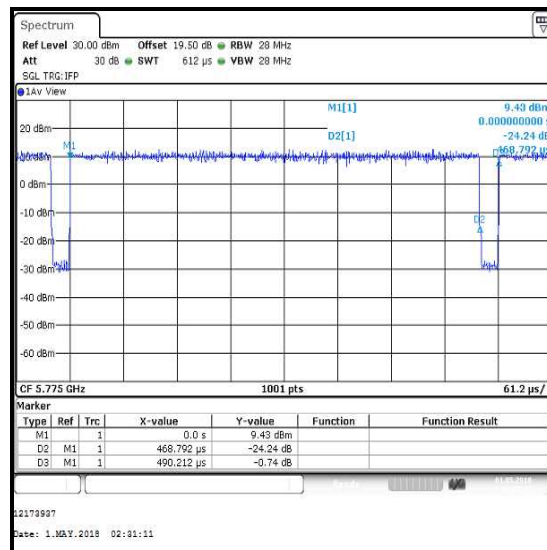


**Transmitter Duty Cycle (continued)****Results: 802.11ac / 80 MHz / MIMO / 2Tx STBC / MCS0x1**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.4612	0.4831	0.2

**Results: 802.11ac / 80 MHz / MIMO / 3Tx STBC / MCS0x1**

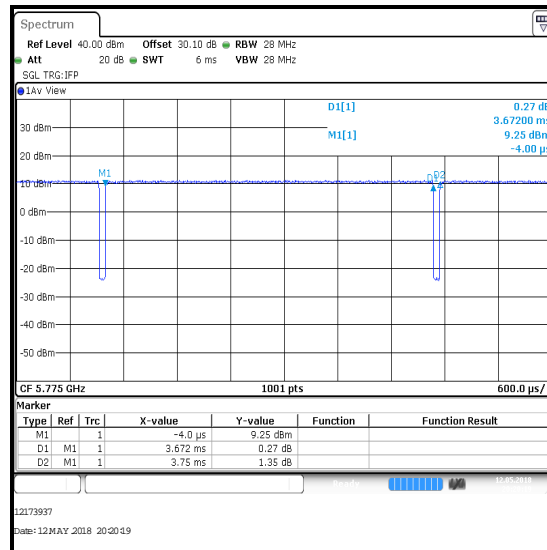
Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.4688	0.4902	0.2



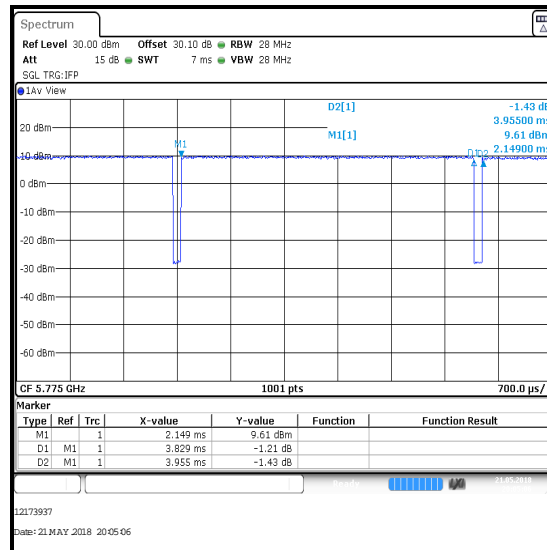


**Transmitter Duty Cycle (continued)****Results: 802.11ac / 80 MHz / MIMO / 2Tx TxBF / MCS0x1**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
3.672	3.750	0.1

**Results: 802.11ac / 80 MHz / MIMO / 3Tx TxBF / MCS0x1**

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
3.829	3.955	0.1



## **4.2. Transmitter 26 dB Emission Bandwidth**

### **Test Summary:**

<b>Test Engineers:</b>	Max Passell & Andrew Edwards	<b>Test Dates:</b>	23 April 2018 to 24 May 2018
<b>Test Sample Serial Numbers:</b>	C02VQ00SJKHY & C02W6002JTF0		

<b>FCC Reference:</b>	Part 15.403(i)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.C.1.

### **Environmental Conditions:**

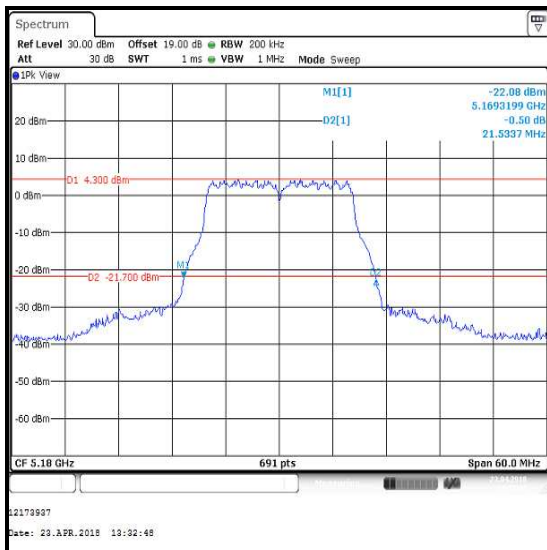
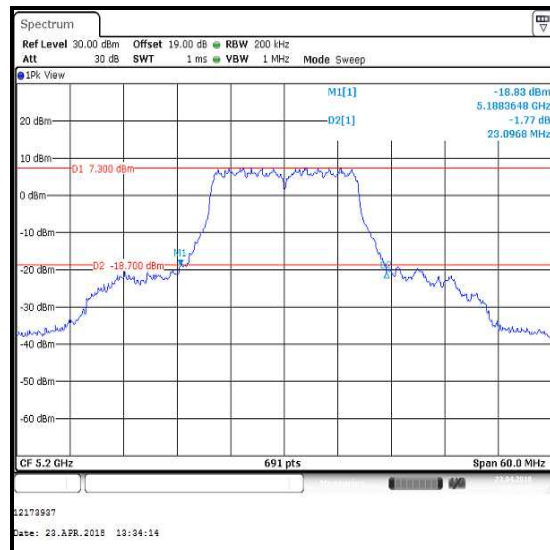
<b>Temperatures (°C):</b>	23 to 25
<b>Relative Humidity (%):</b>	30 to 42

### **Note(s):**

1. Measurements were performed on data rates detailed in Section 3.5 on the relevant channels.
2. The signal analyser's resolution bandwidth was set to approximately 1% of the measured 26 dB emission bandwidth.
3. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
4. For channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz, emission bandwidth measurements were performed twice. Measurements of the entire 26 dB emission bandwidth that is contained on both U-NII-2C and U-NII-3 bands, were used for power measurements. Measurements on the emission's portion that is contained only within the U-NII-2C band, were used to calculate the conducted power limit on U-NII-2C tests. These are labelled as 'Reference plots'.
5. The EUT with serial number C02VQ00SJKHY was used for non-TxBF tests, the EUT with serial number C02W6002JTF0 was used for TxBF tests.

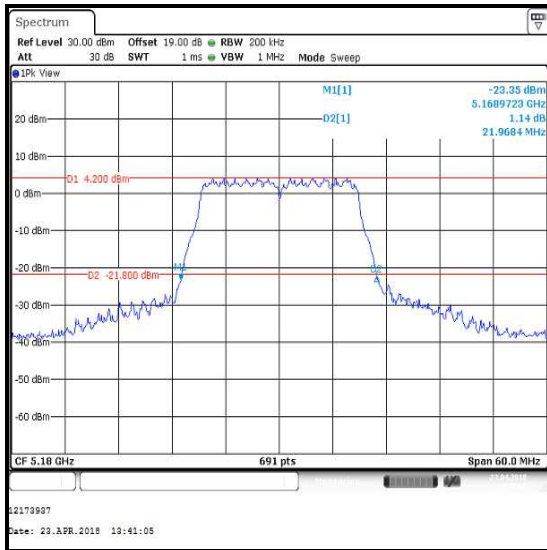
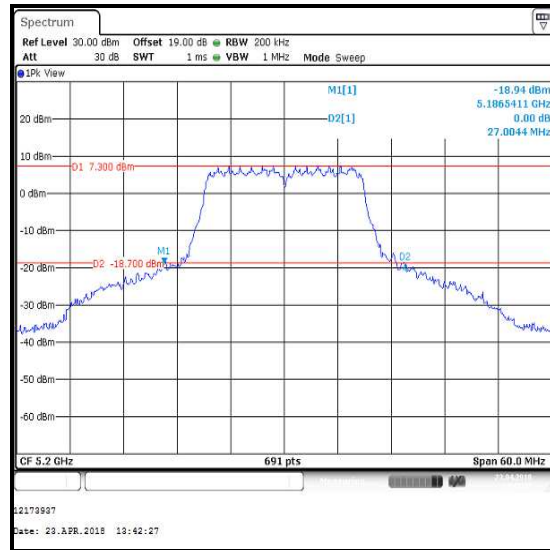
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****4.2.1. 5.15-5.25 GHz band****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.534
Middle	5200	23.097
Top	5240	31.085

**Bottom Channel****Middle Channel****Top Channel**

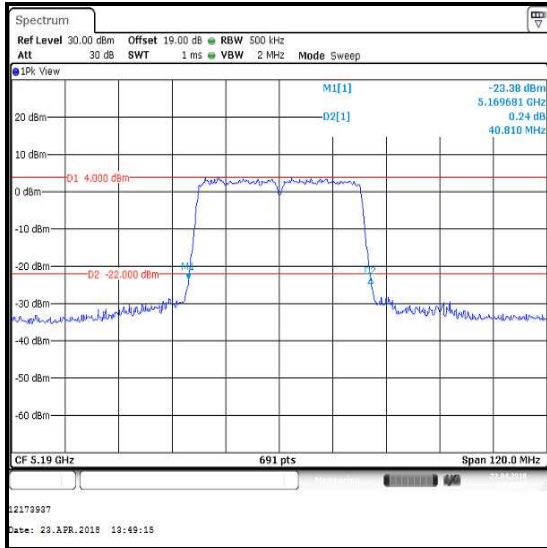
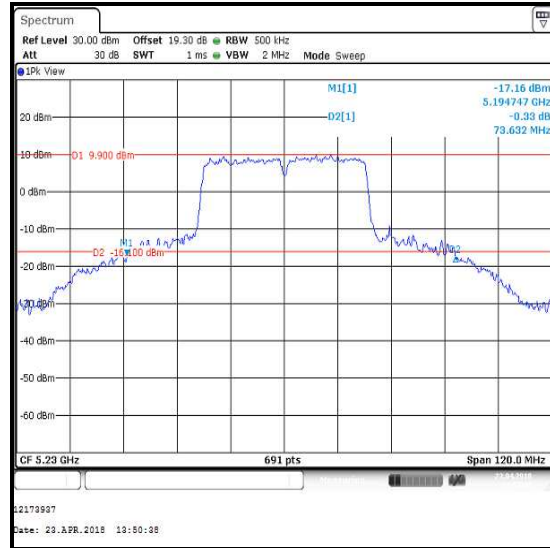
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.968
Middle	5200	27.004
Top	5240	30.044

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Port WF1**

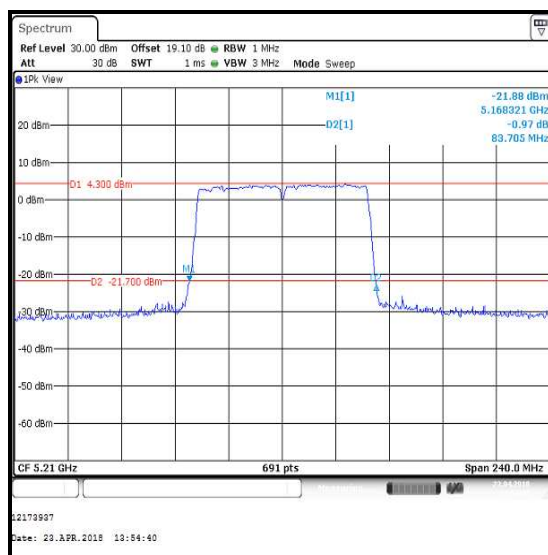
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.810
Top	5230	73.632

**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)**

**Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Port WF1**

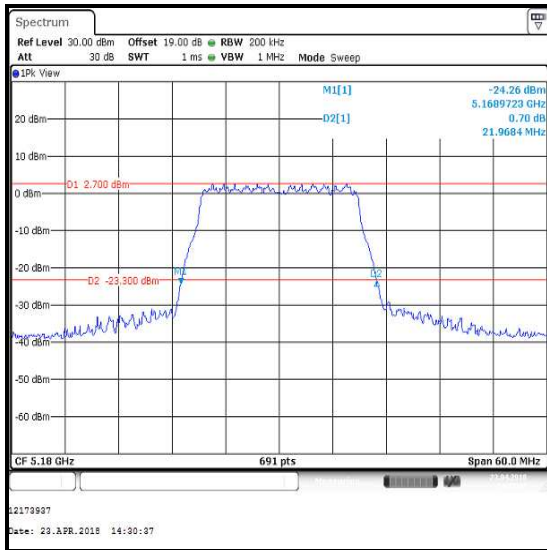
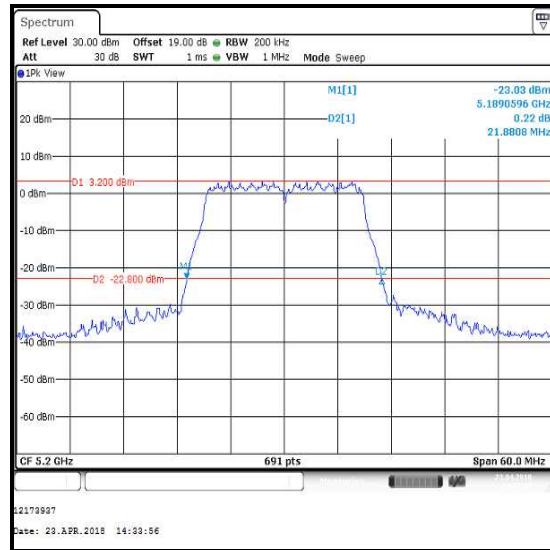
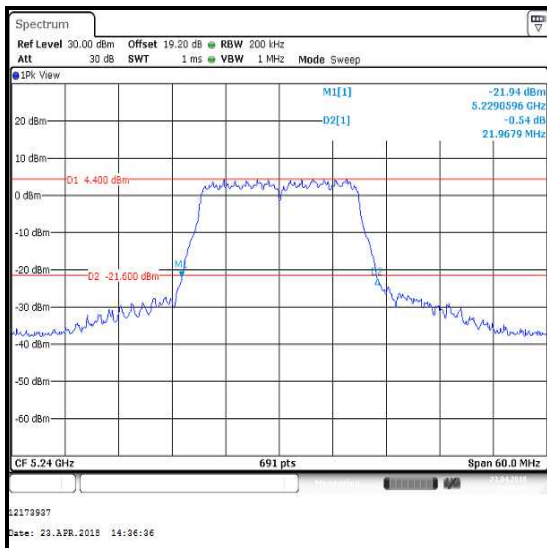
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.705



## Single Channel

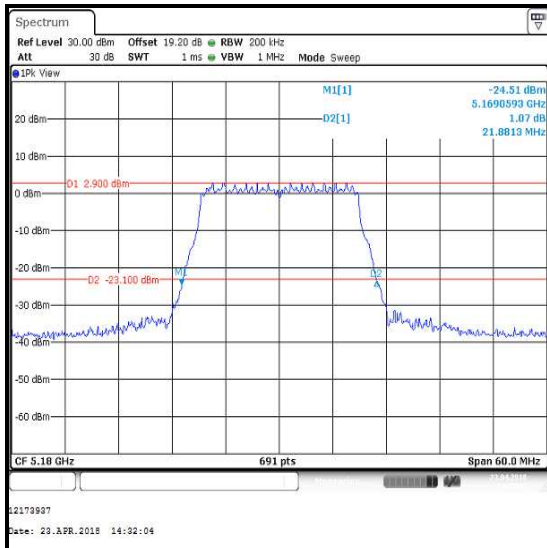
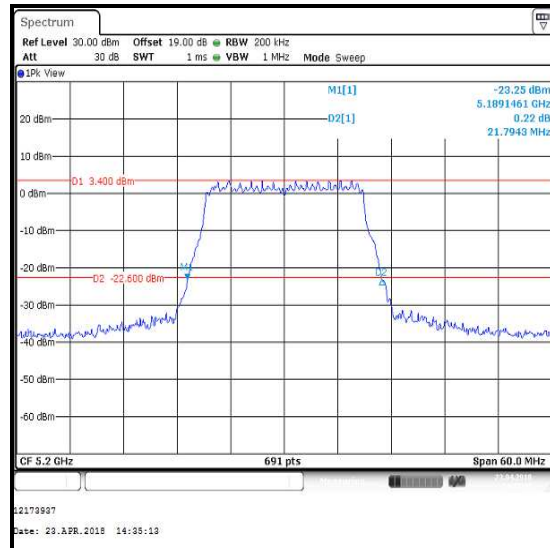
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.968
Middle	5200	21.881
Top	5240	21.968

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF3**

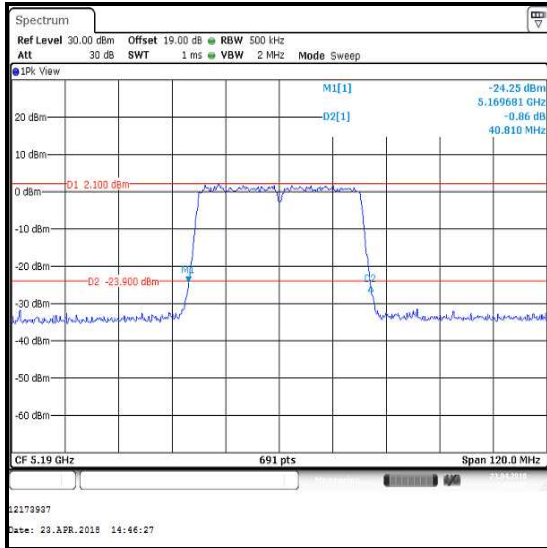
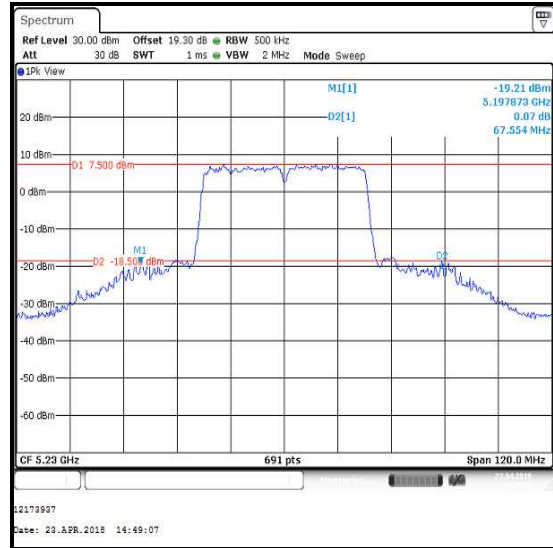
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.881
Middle	5200	21.794
Top	5240	21.881

**Bottom Channel****Middle Channel****Top Channel**



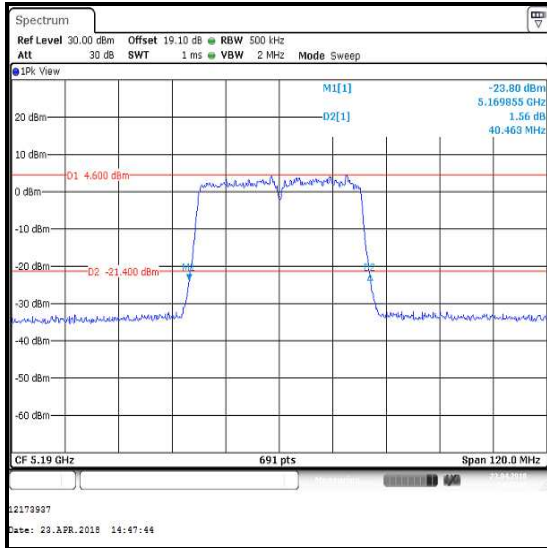
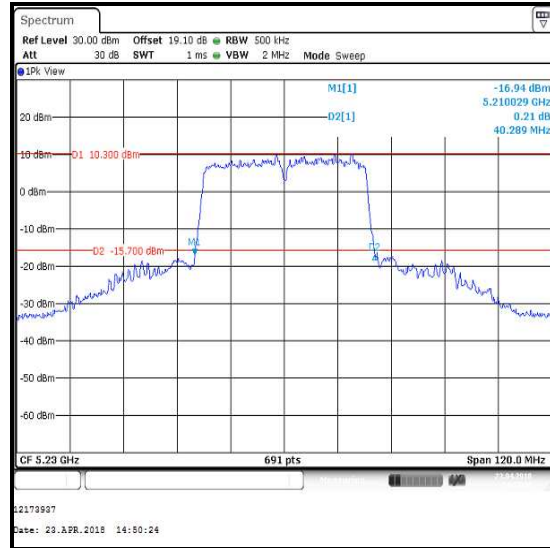
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.810
Top	5230	67.554

**Bottom Channel****Top Channel**

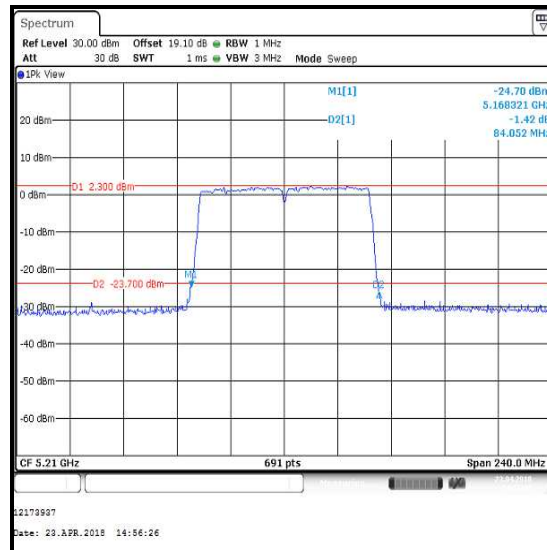
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.463
Top	5230	40.289

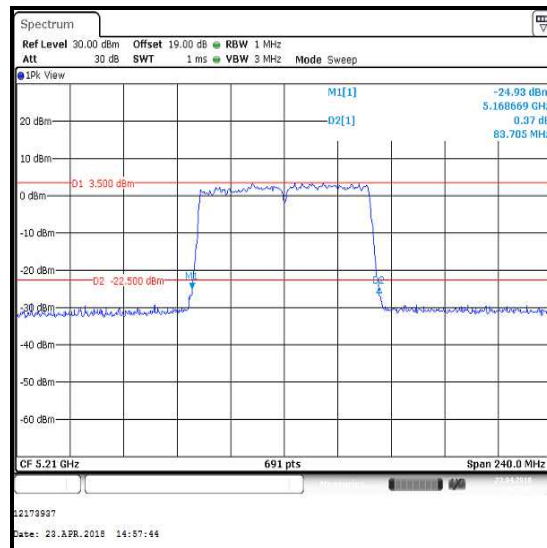
**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	84.052

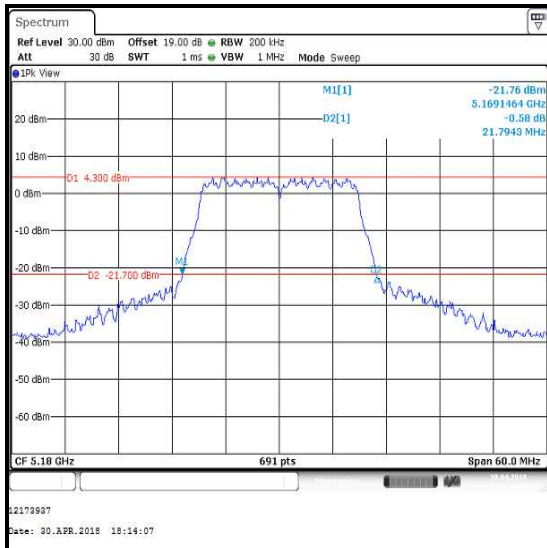
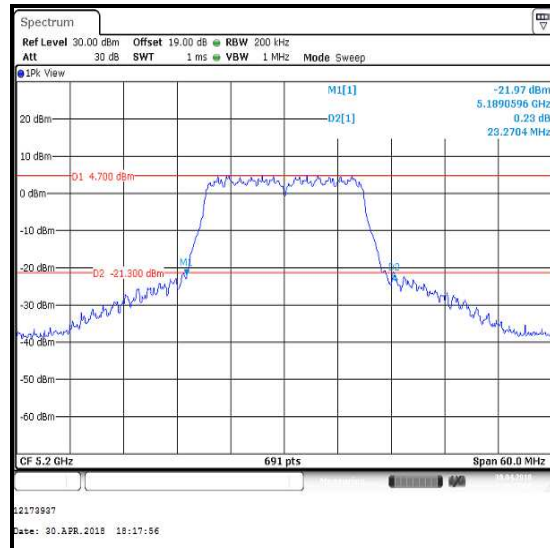
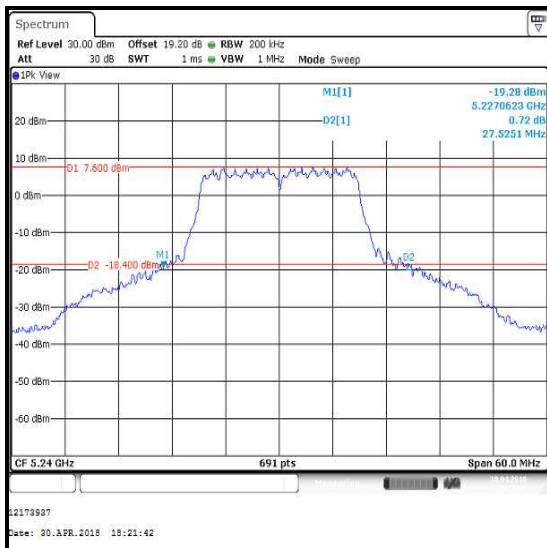
**Single Channel****Results: 802.11ac / 80 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.705

**Single Channel**

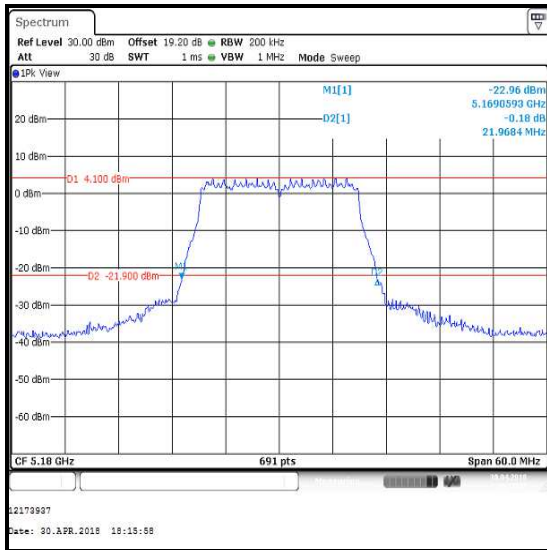
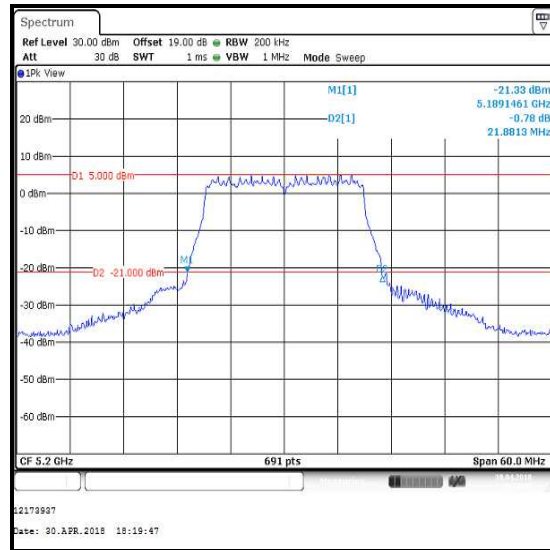
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx STBC / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.794
Middle	5200	23.270
Top	5240	27.525

**Bottom Channel****Middle Channel****Top Channel**

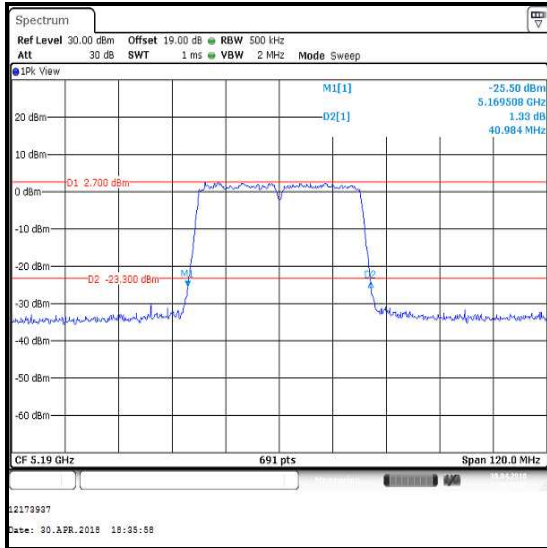
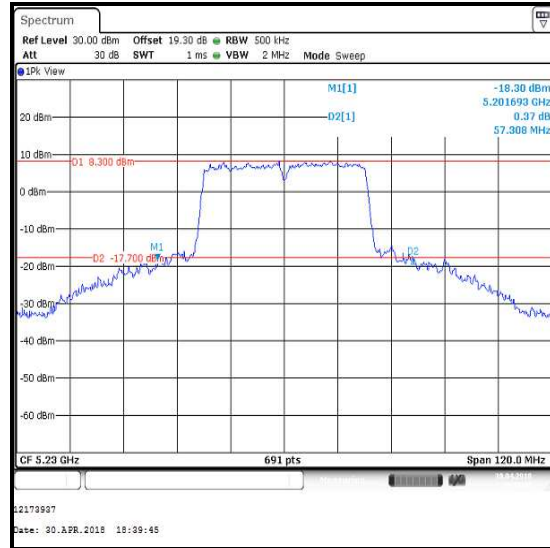
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx STBC / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.968
Middle	5200	21.881
Top	5240	22.836

**Bottom Channel****Middle Channel****Top Channel**

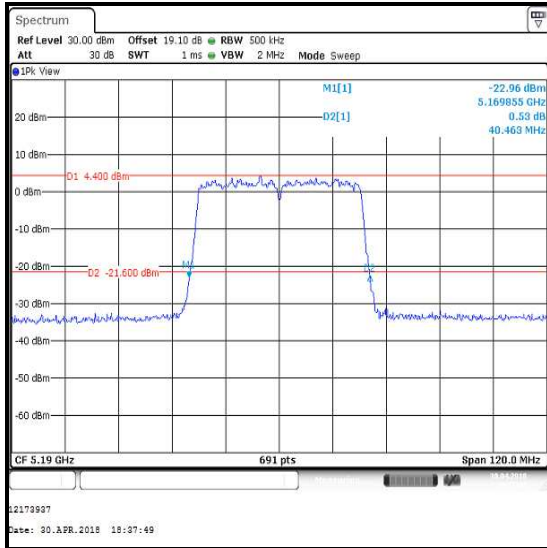
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx STBC / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.984
Top	5230	57.308

**Bottom Channel****Top Channel**

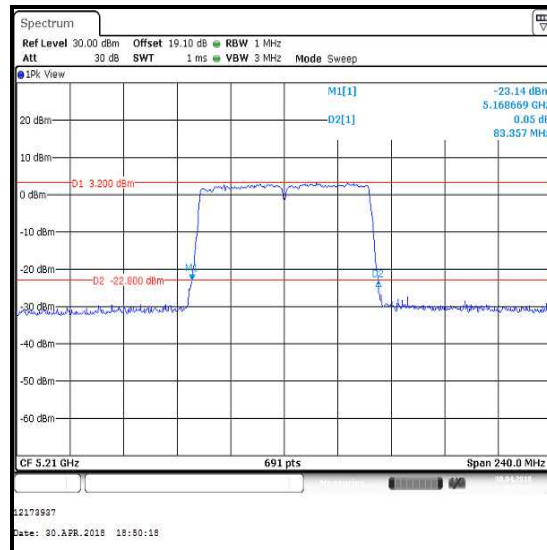
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx STBC / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.463
Top	5230	44.110

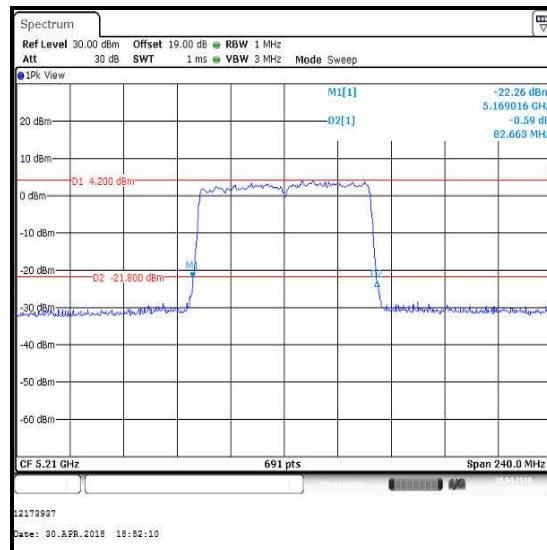
**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 2Tx STBC / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.357

**Single Channel****Results: 802.11ac / 80 MHz / MIMO / 2Tx STBC / BPSK / MCS0 / Port WF3**

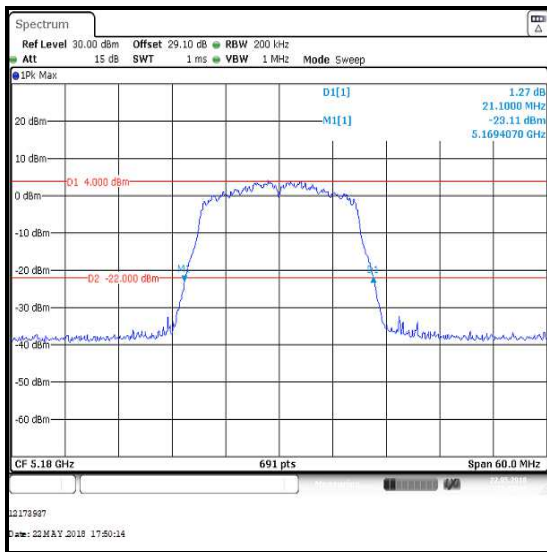
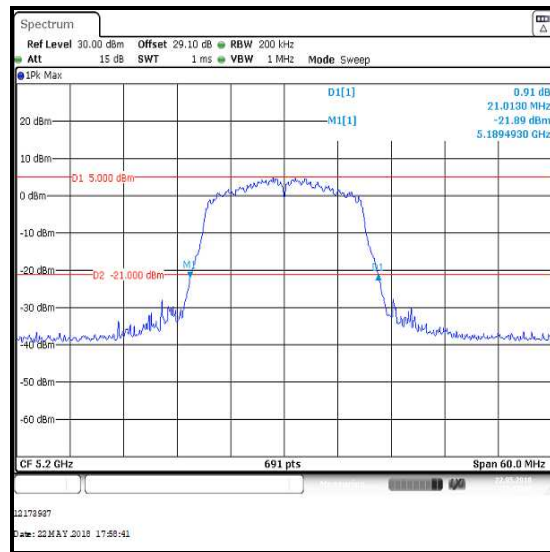
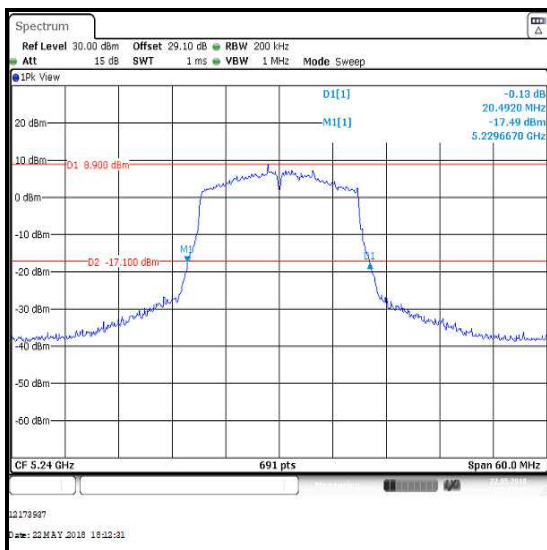
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	82.663

**Single Channel**



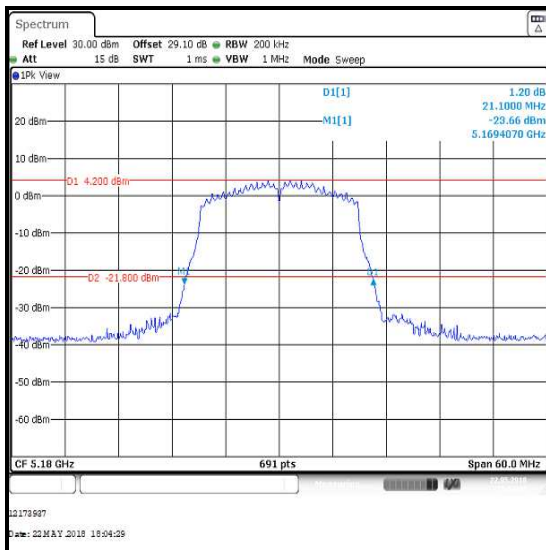
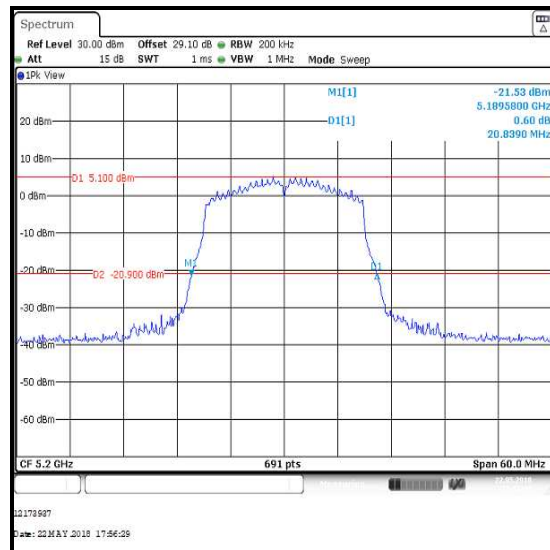
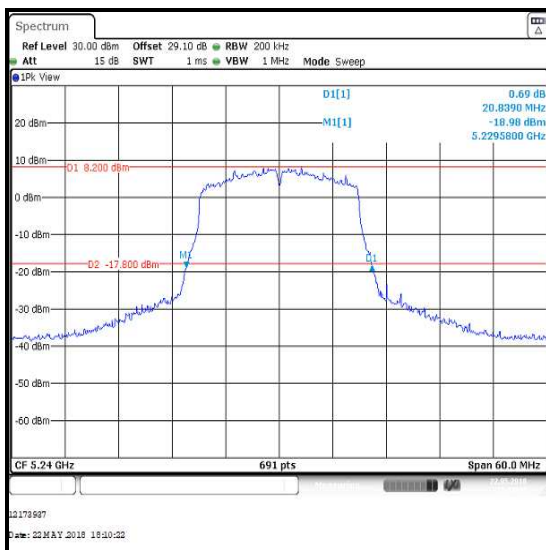
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx TxBF / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.100
Middle	5200	21.013
Top	5240	20.492

**Bottom Channel****Middle Channel****Top Channel**

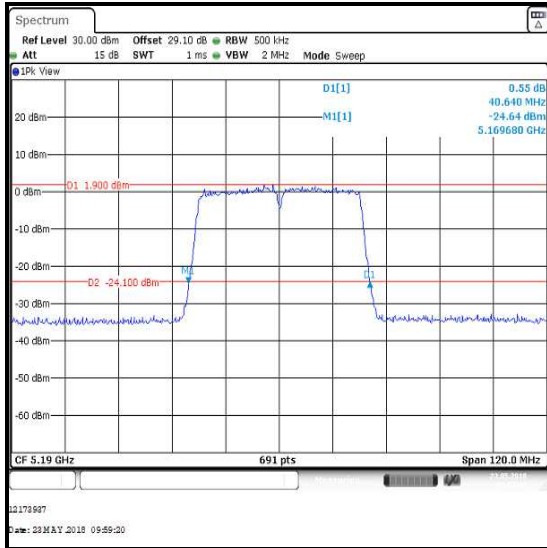
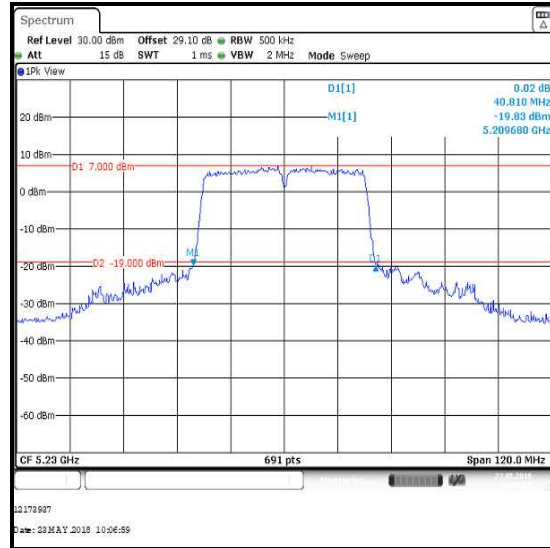
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx TxBF / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.100
Middle	5200	20.839
Top	5240	20.839

**Bottom Channel****Middle Channel****Top Channel**

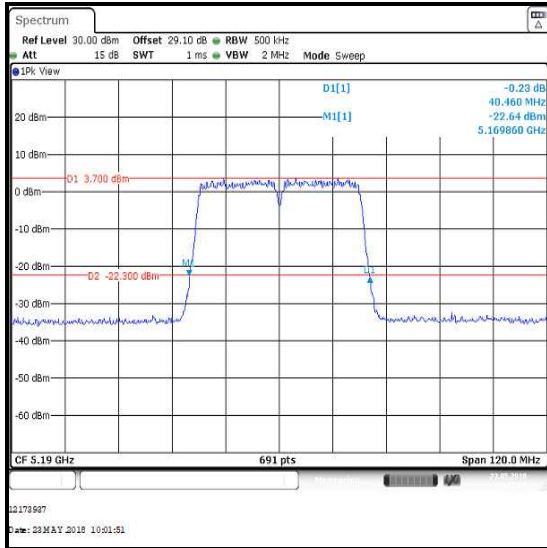
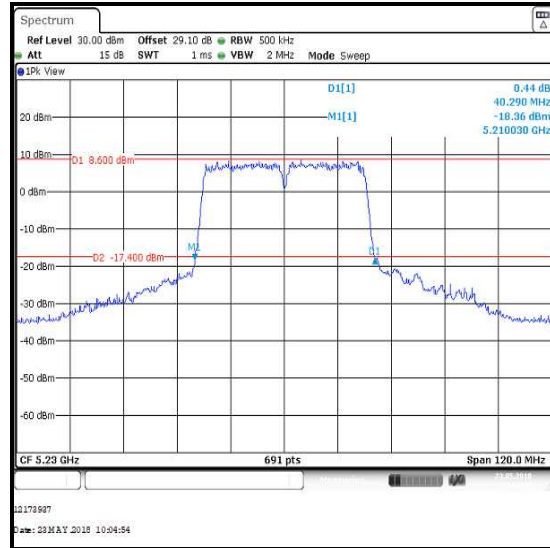
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx TxBF / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.640
Top	5230	40.810

**Bottom Channel****Top Channel**

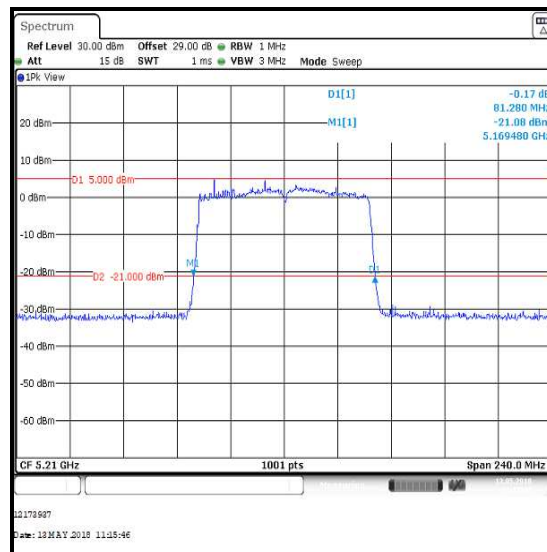
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx TxBF / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.460
Top	5230	40.290

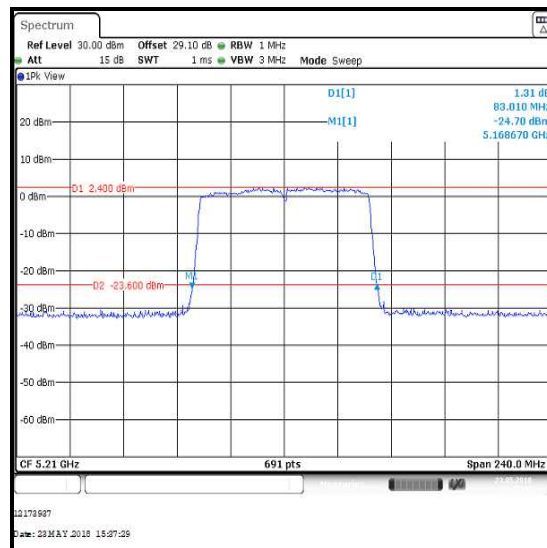
**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 2Tx TxBF / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	81.280

**Single Channel****Results: 802.11ac / 80 MHz / MIMO / 2Tx TxBF / BPSK / MCS0 / Port WF3**

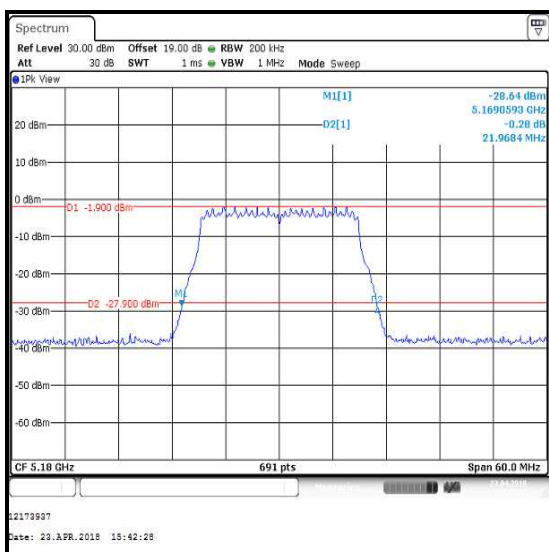
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.010

**Single Channel**

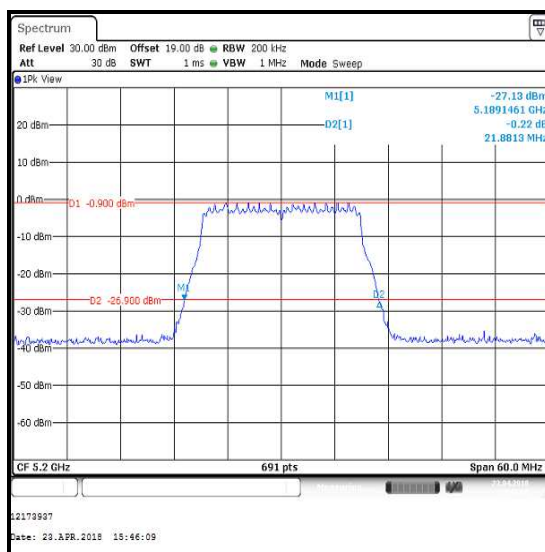
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)**

**Results: 802.11n / 20 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF1**

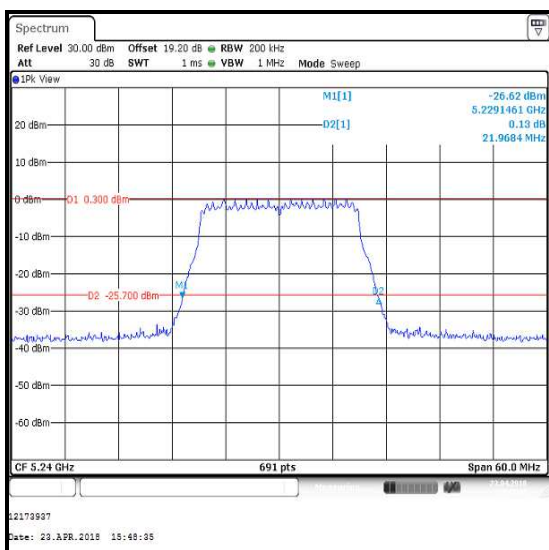
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.968
Middle	5200	21.881
Top	5240	21.968



### Bottom Channel



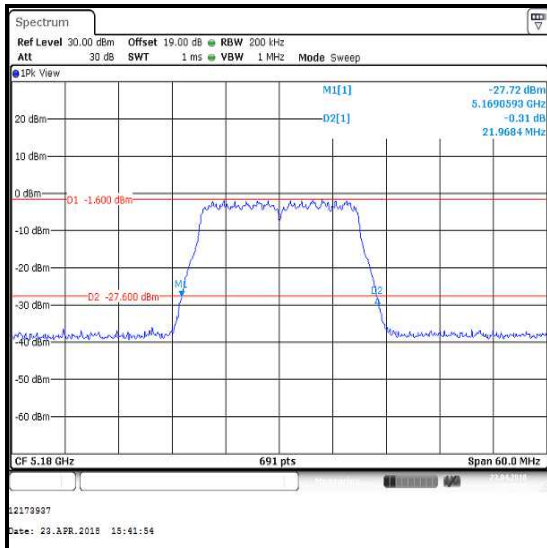
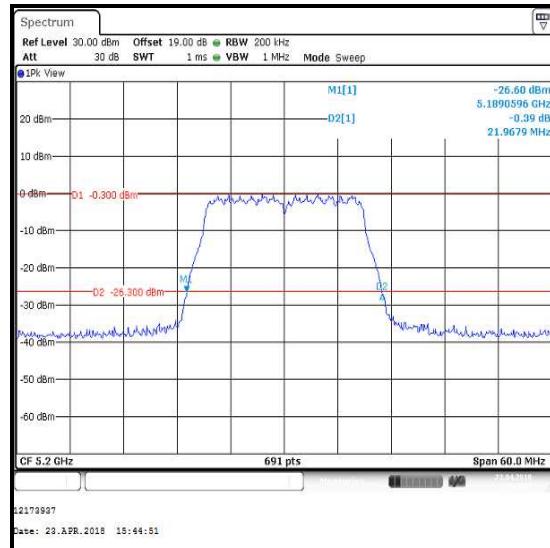
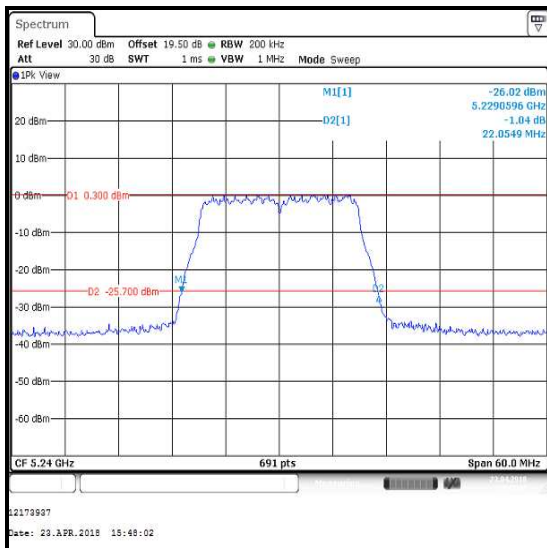
## Middle Channel



## Top Channel

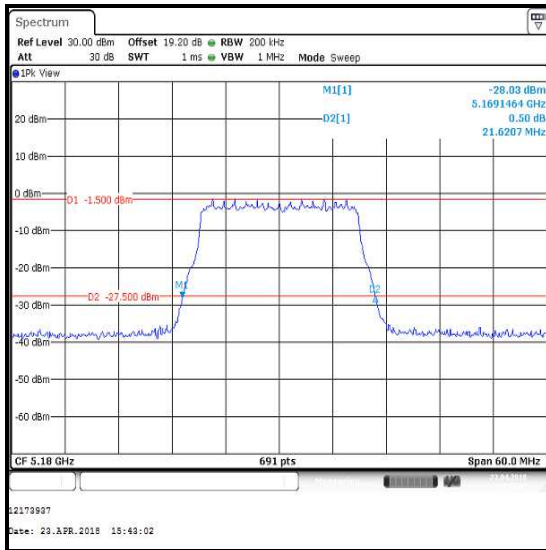
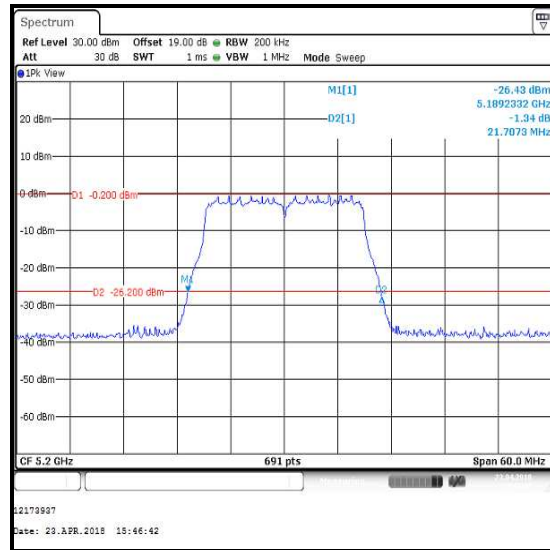
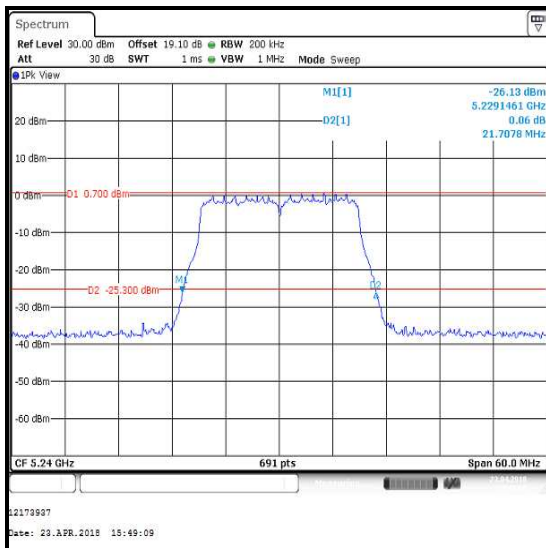
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.968
Middle	5200	21.968
Top	5240	22.055

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF3**

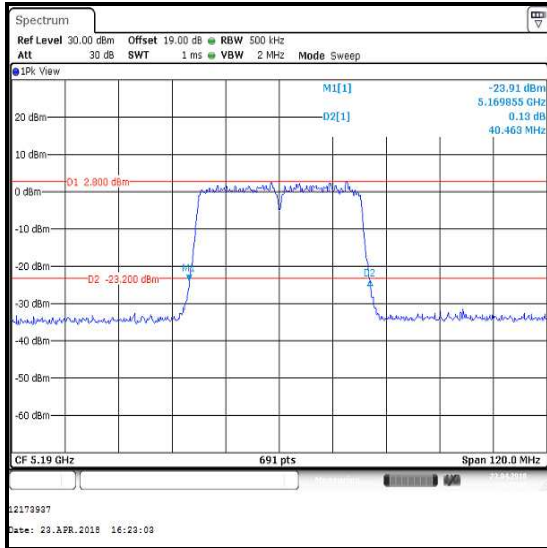
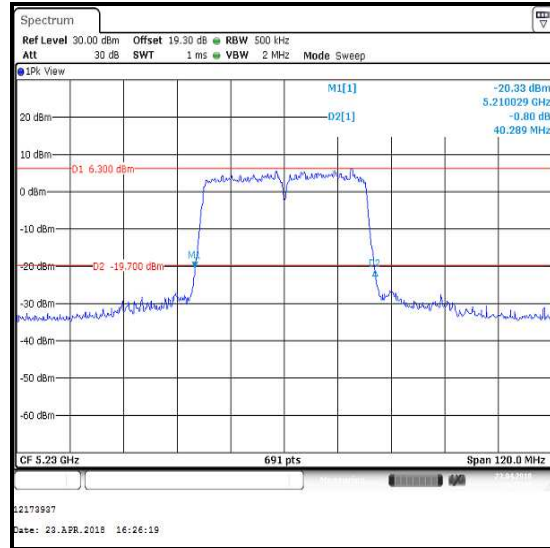
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.621
Middle	5200	21.707
Top	5240	21.708

**Bottom Channel****Middle Channel****Top Channel**



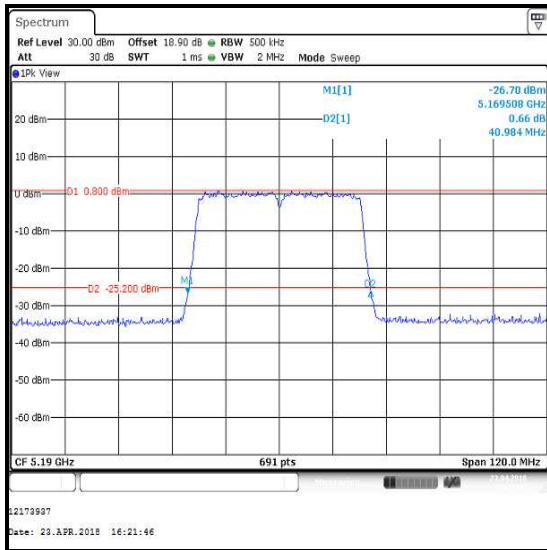
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.463
Top	5230	40.289

**Bottom Channel****Top Channel**

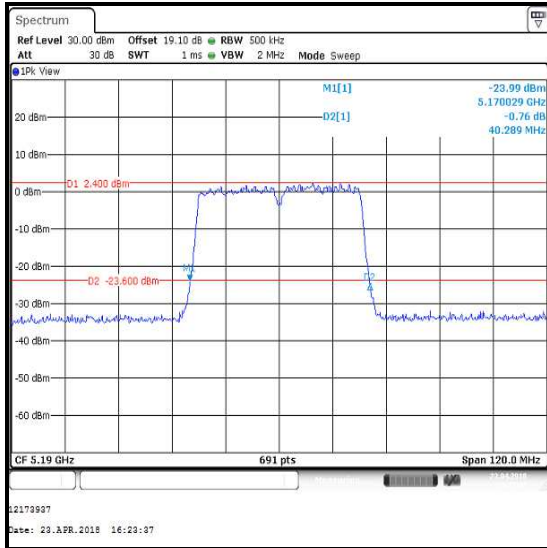
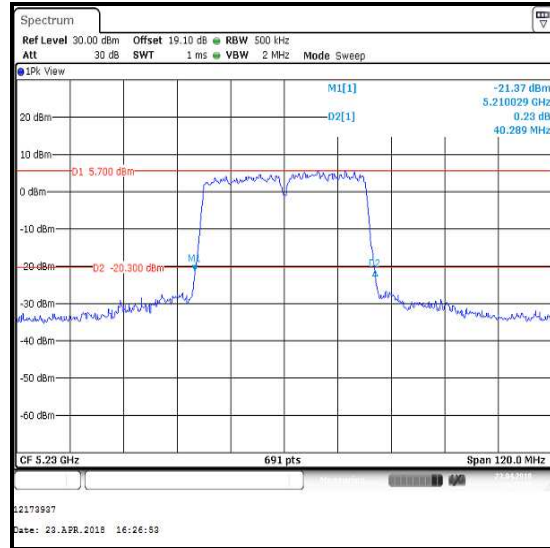
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.984
Top	5230	40.810

**Bottom Channel****Top Channel**

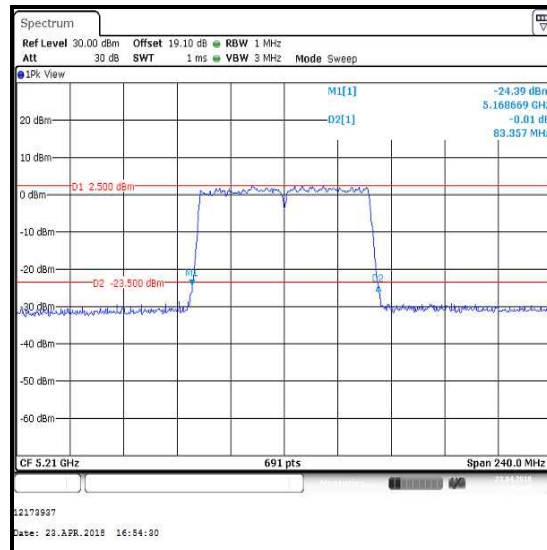
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.289
Top	5230	40.289

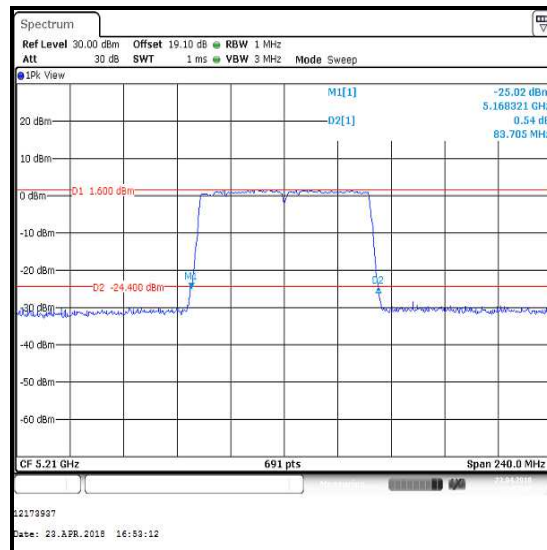
**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.357

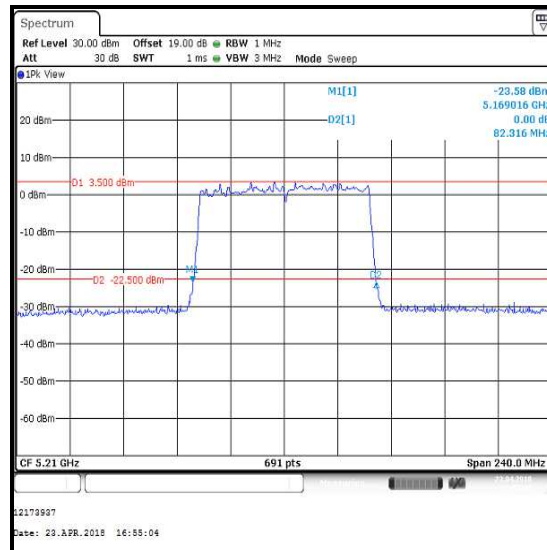
**Single Channel****Results: 802.11ac / 80 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.705

**Single Channel**

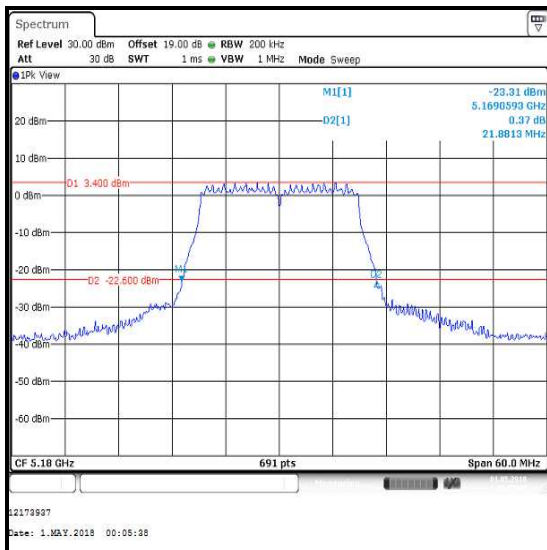
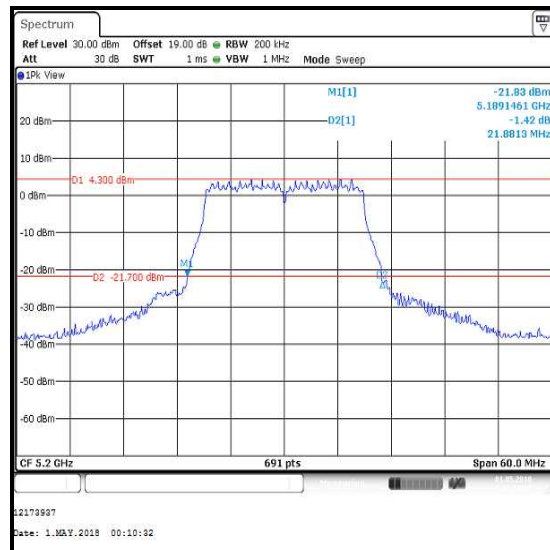
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 3Tx CDD / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	82.316

**Single Channel**

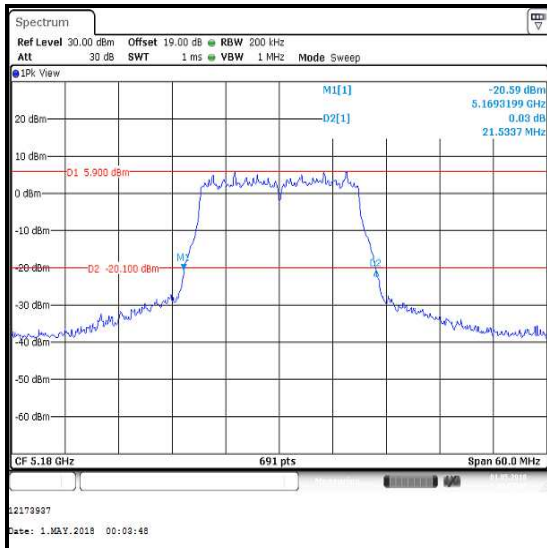
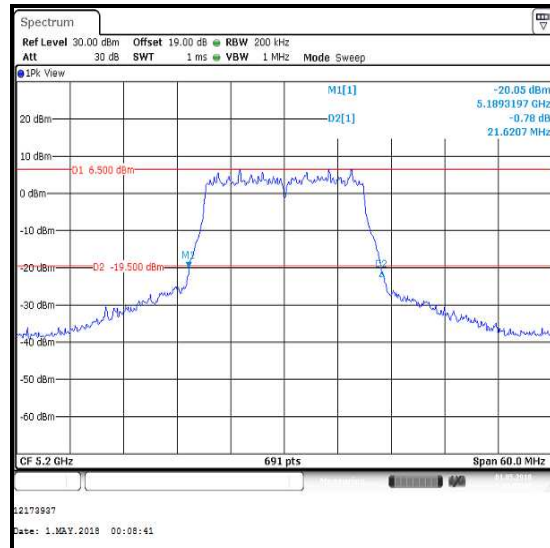
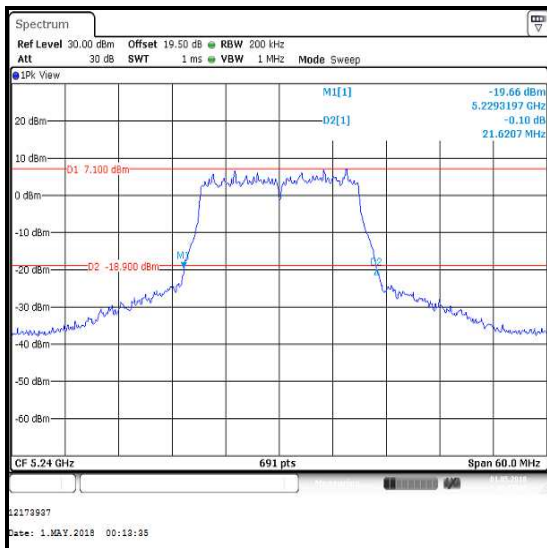
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.881
Middle	5200	21.881
Top	5240	21.881

**Bottom Channel****Middle Channel****Top Channel**

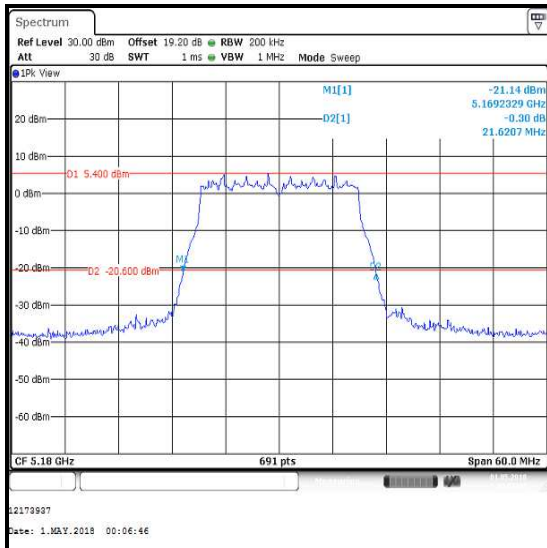
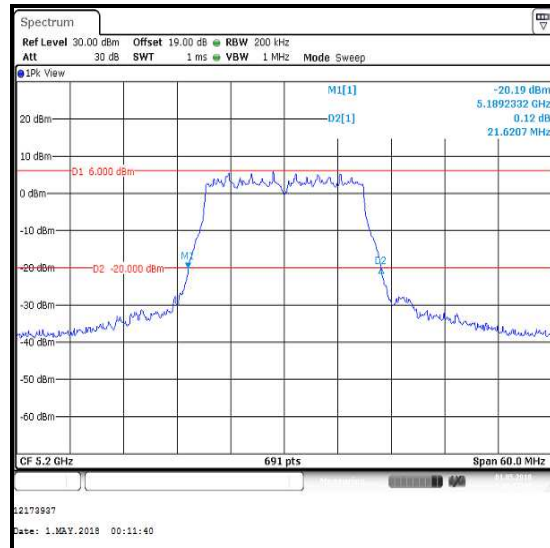
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.534
Middle	5200	21.621
Top	5240	21.621

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF3**

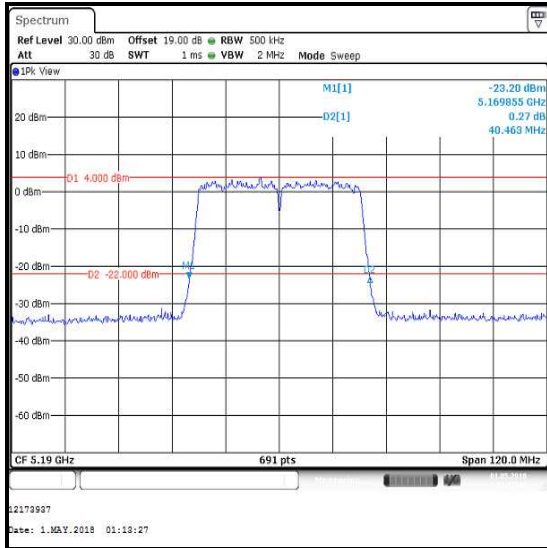
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.621
Middle	5200	21.621
Top	5240	21.621

**Bottom Channel****Middle Channel****Top Channel**



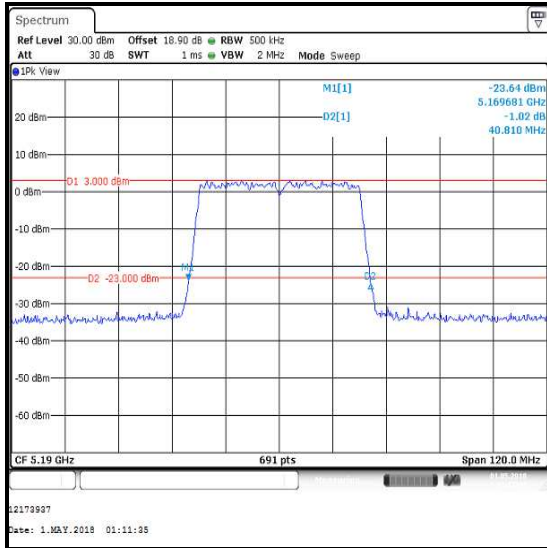
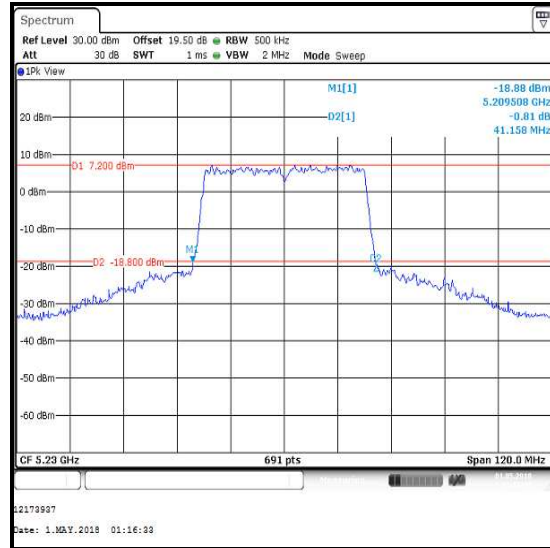
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.463
Top	5230	40.289

**Bottom Channel****Top Channel**

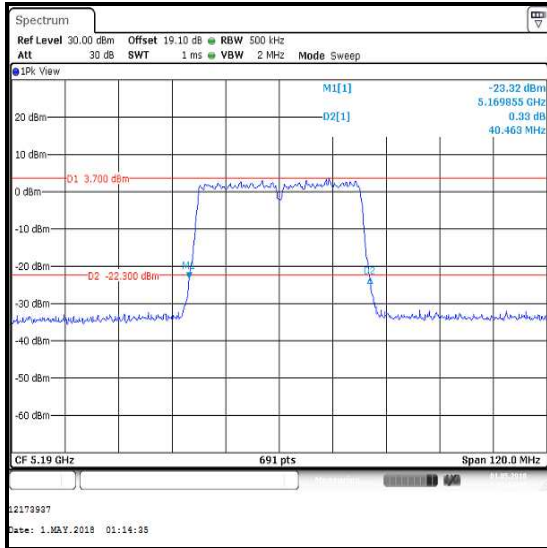
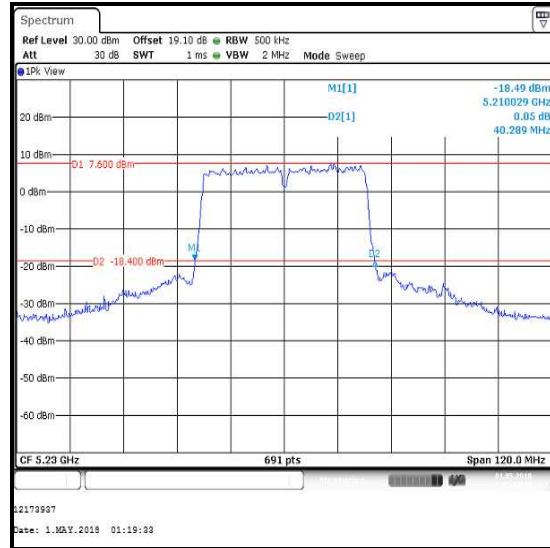
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.810
Top	5230	41.158

**Bottom Channel****Top Channel**

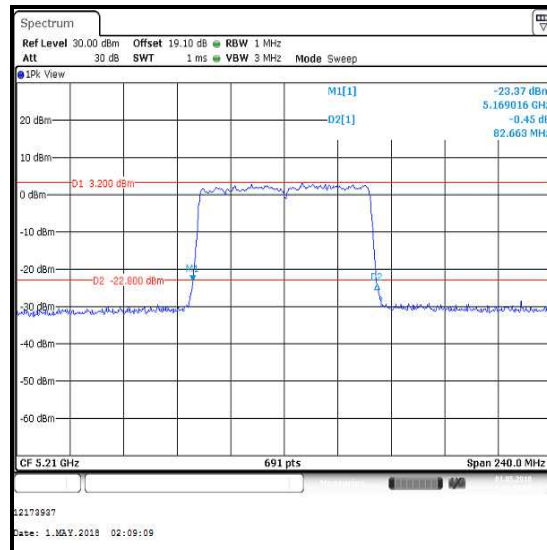
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.463
Top	5230	40.289

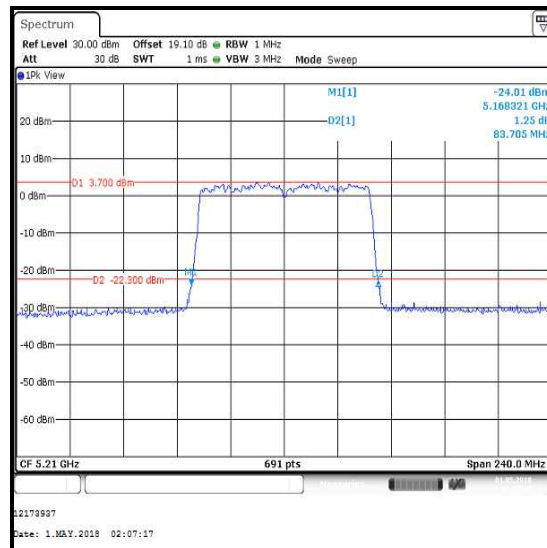
**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	82.663

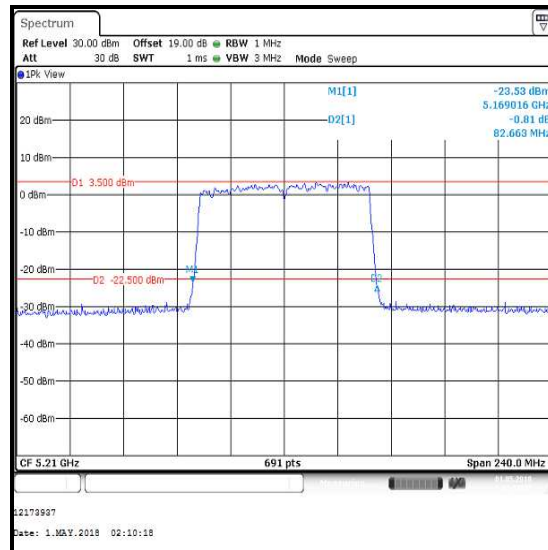
**Single Channel****Results: 802.11ac / 80 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.705

**Single Channel**

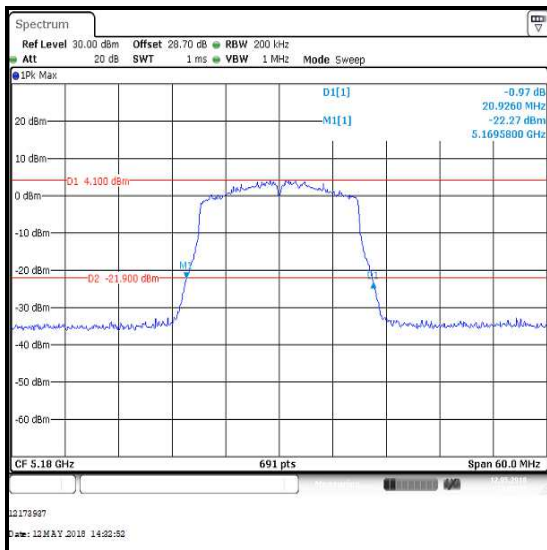
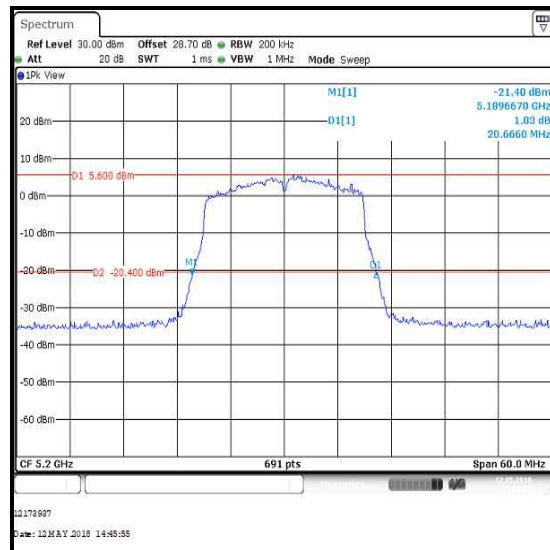
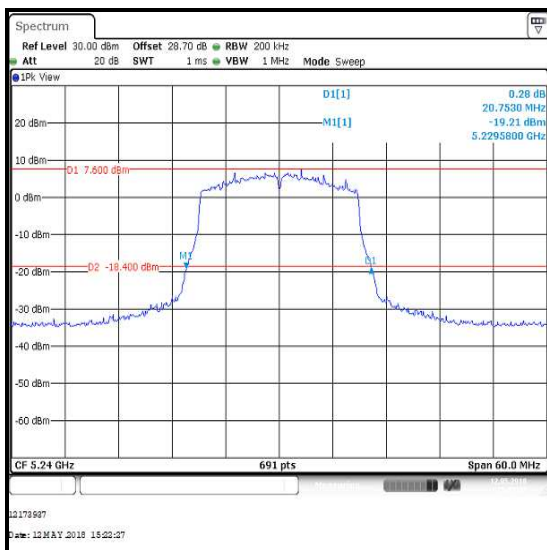
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 3Tx STBC / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	82.663

**Single Channel**

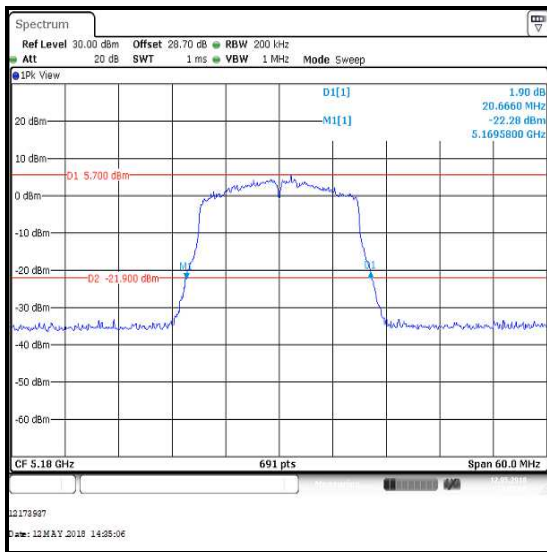
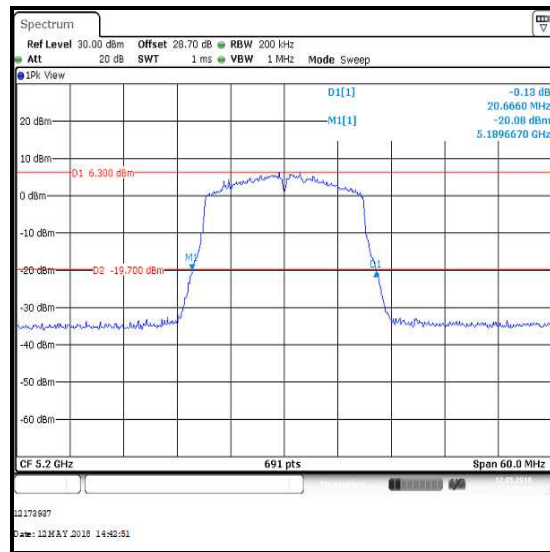
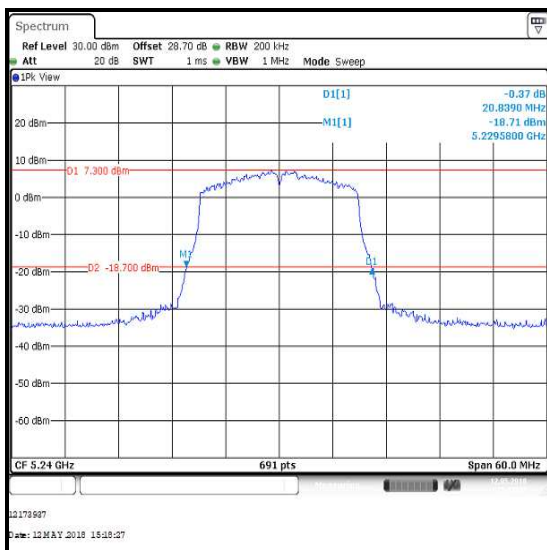
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	20.926
Middle	5200	20.666
Top	5240	20.753

**Bottom Channel****Middle Channel****Top Channel**

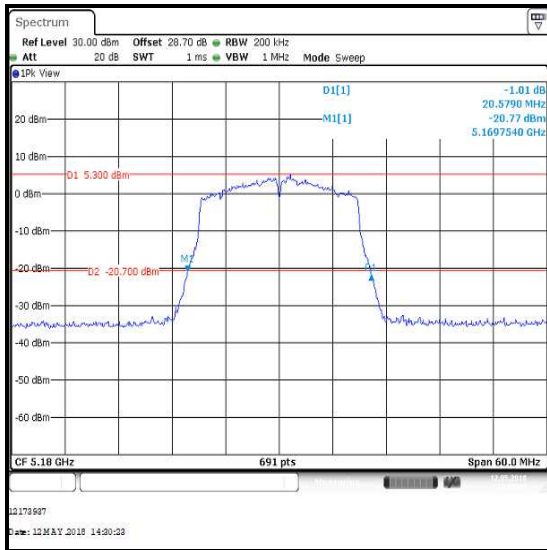
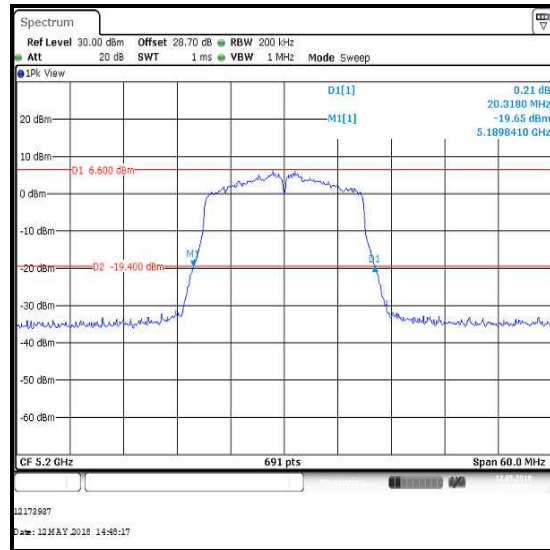
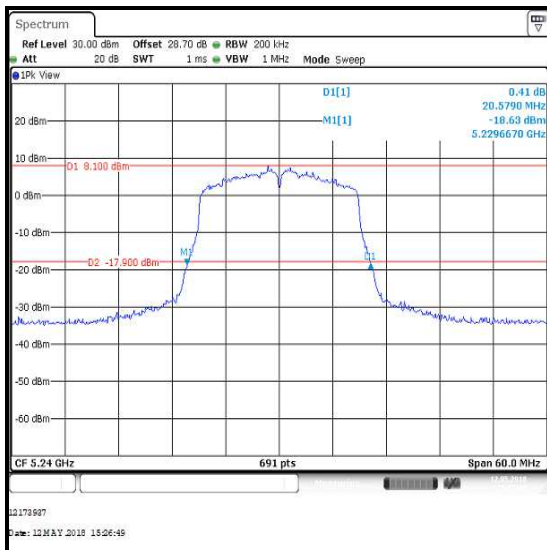
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	20.666
Middle	5200	20.666
Top	5240	20.839

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF3**

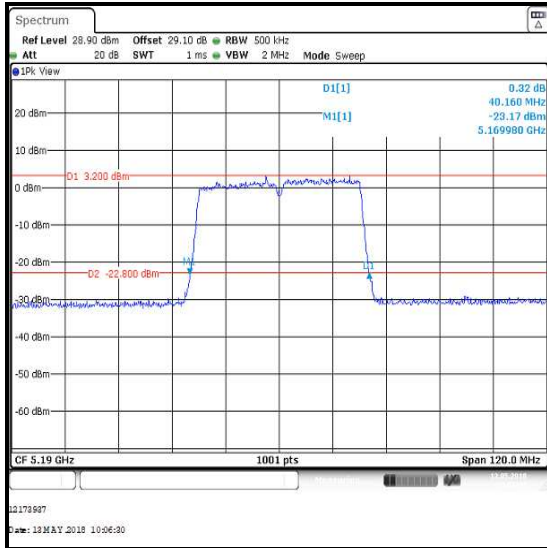
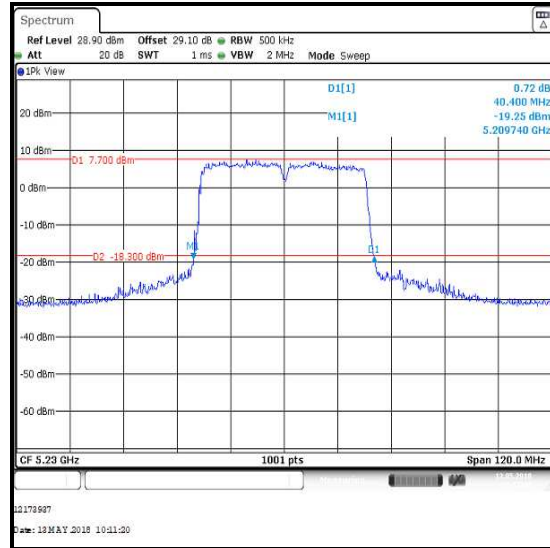
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	20.579
Middle	5200	20.318
Top	5240	20.579

**Bottom Channel****Middle Channel****Top Channel**



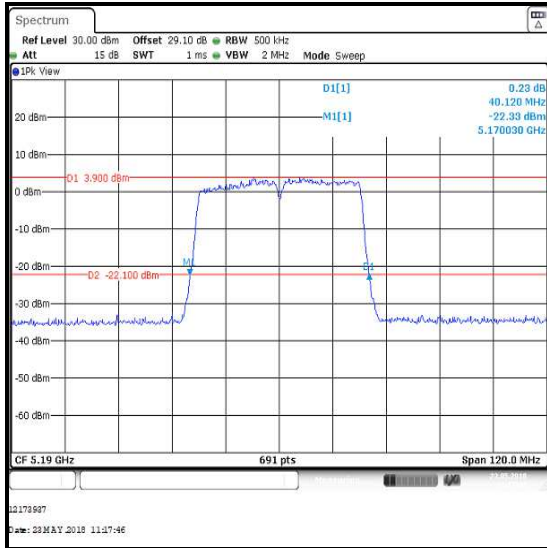
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.160
Top	5230	40.400

**Bottom Channel****Top Channel**

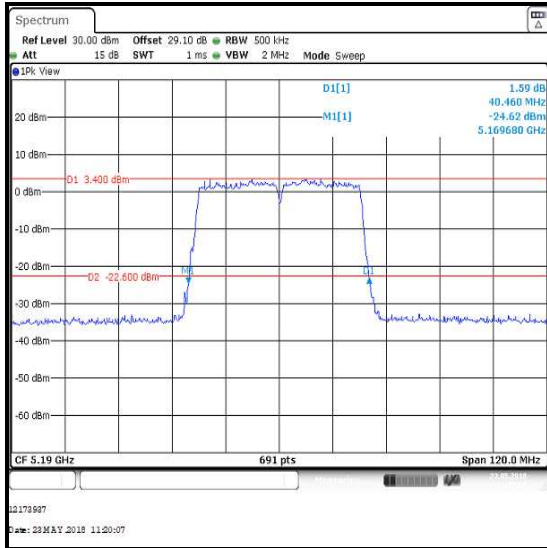
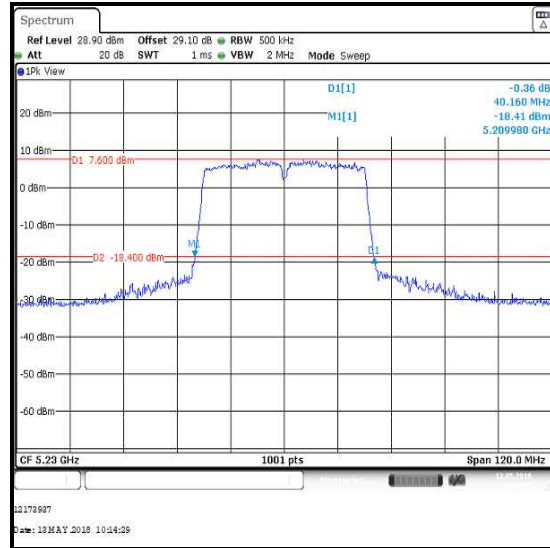
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.120
Top	5230	40.280

**Bottom Channel****Top Channel**

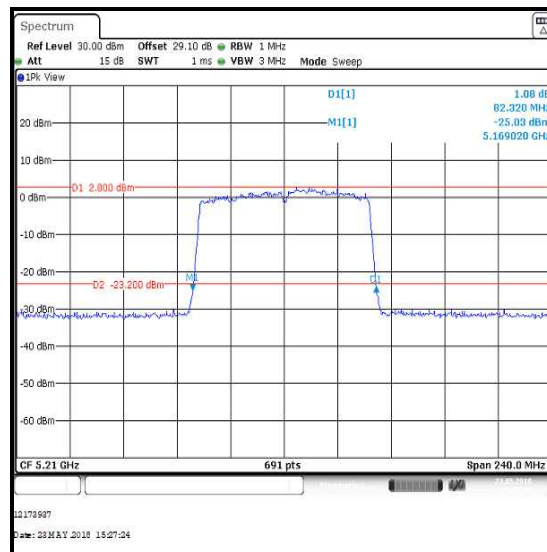
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.460
Top	5230	40.160

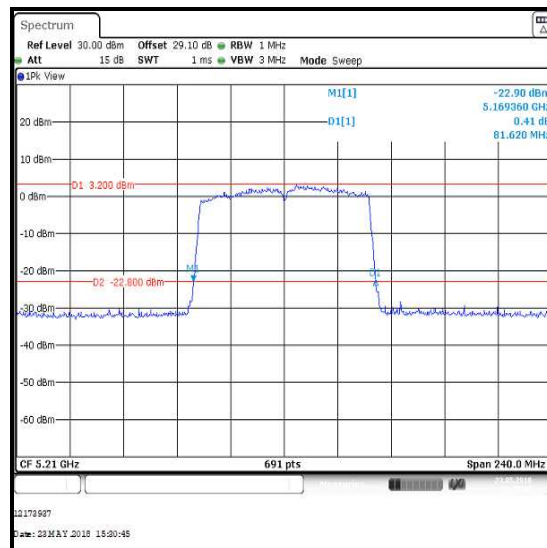
**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	82.320

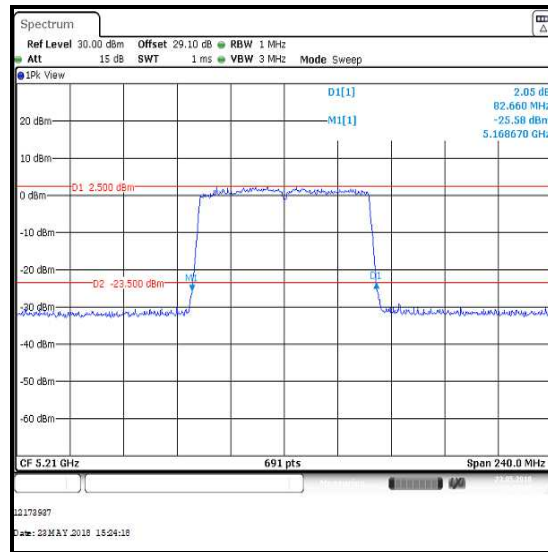
**Single Channel****Results: 802.11ac / 80 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	81.620

**Single Channel**

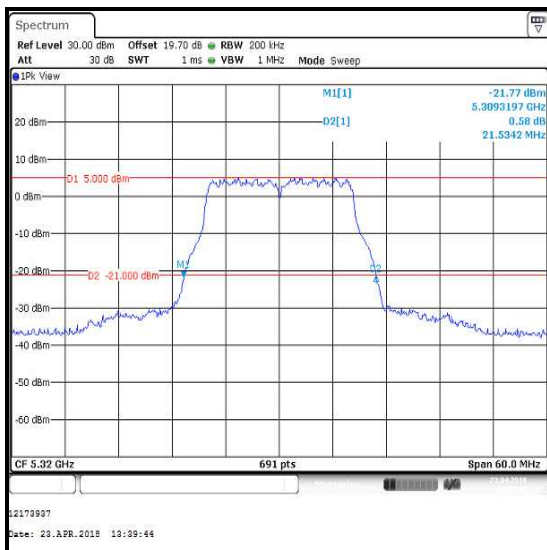
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 3Tx TxBF / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	82.660

**Single Channel**

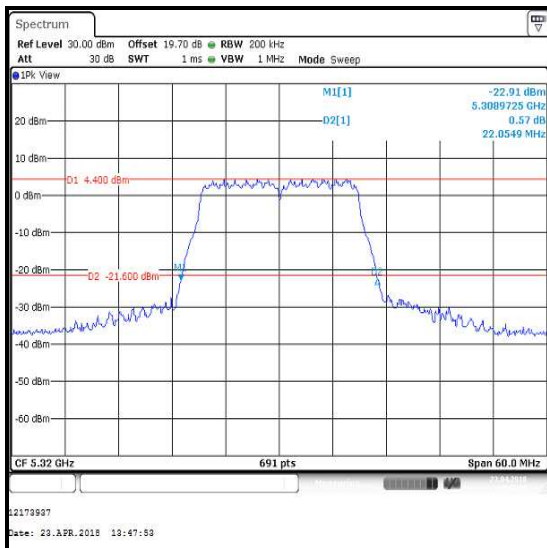
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****4.2.2. 5.25-5.35 GHz band****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	27.786
Middle	5280	24.834
Top	5320	21.534

**Bottom Channel****Middle Channel****Top Channel**

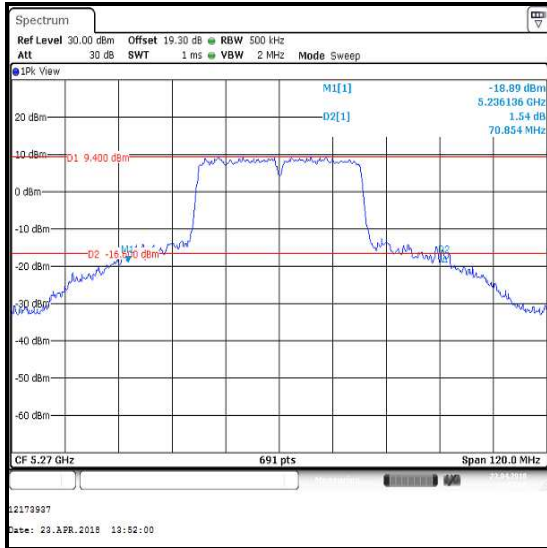
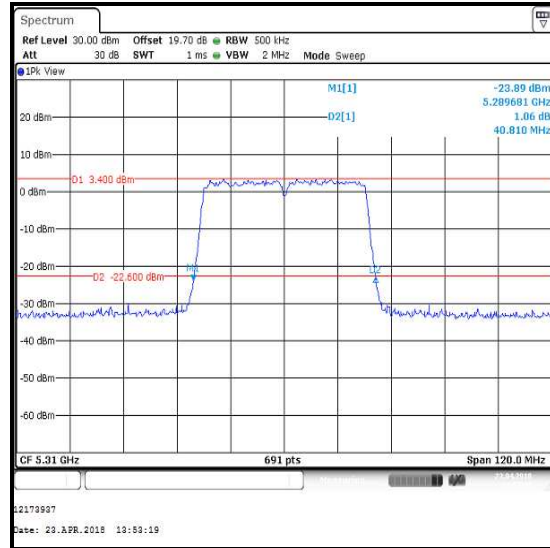
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	27.959
Middle	5280	27.873
Top	5320	22.055

**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5270	70.854
Top	5310	40.810

**Bottom Channel****Top Channel**



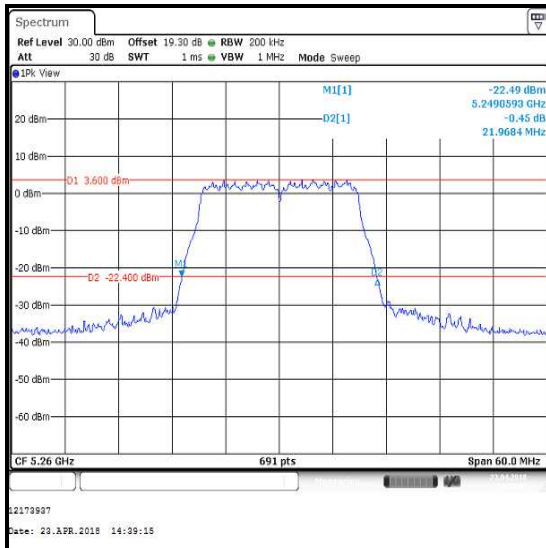
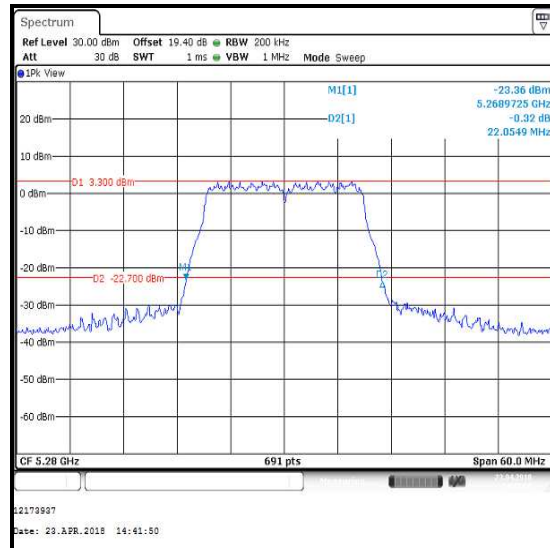
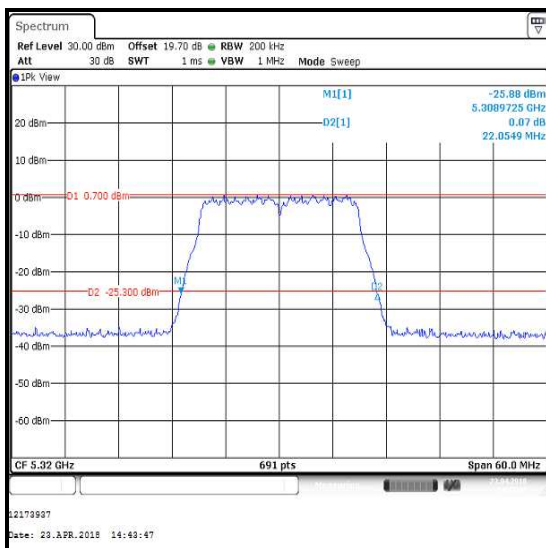
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5290	83.357

**Single Channel**

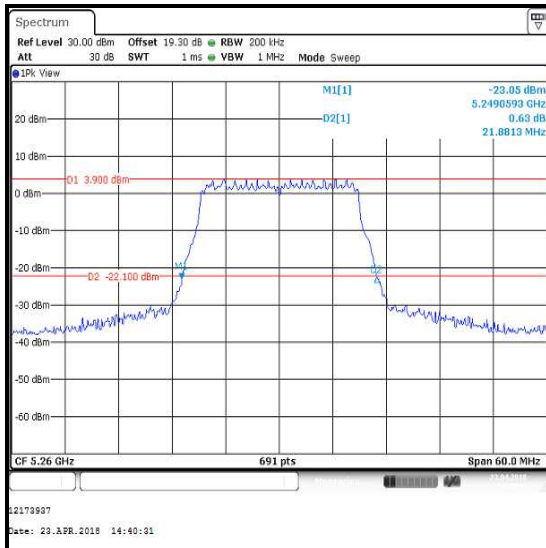
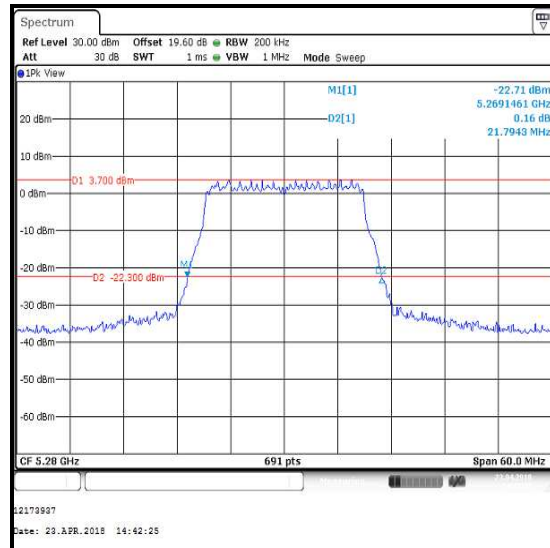
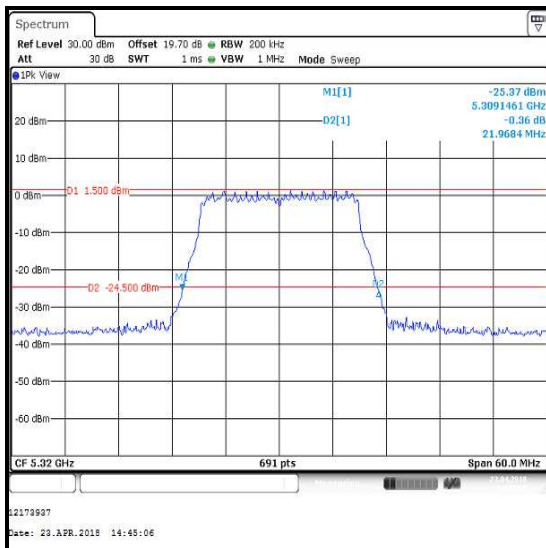
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	21.968
Middle	5280	22.055
Top	5320	22.055

**Bottom Channel****Middle Channel****Top Channel**

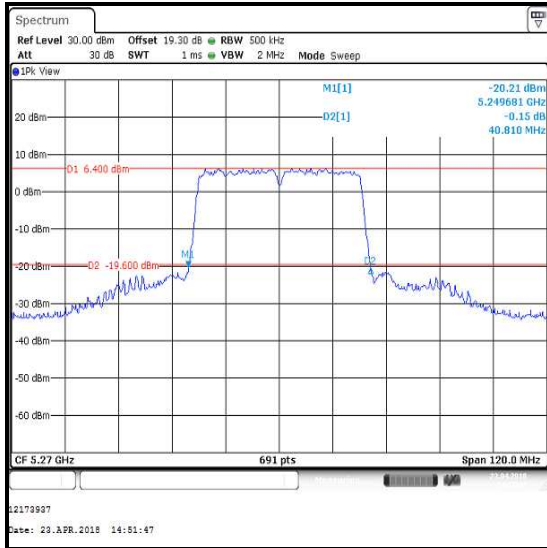
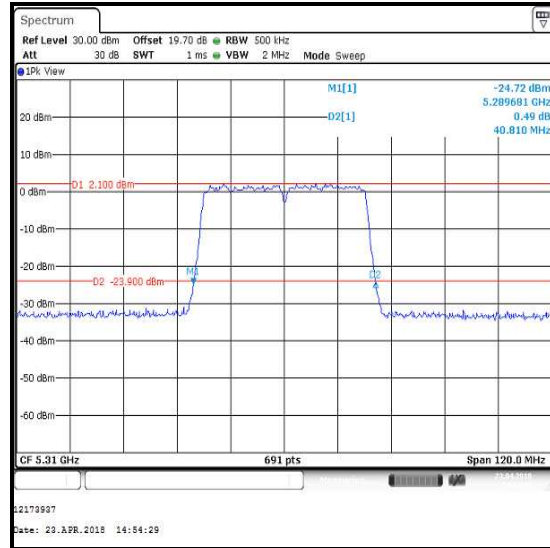
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 20 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	21.881
Middle	5280	21.794
Top	5320	21.968

**Bottom Channel****Middle Channel****Top Channel**

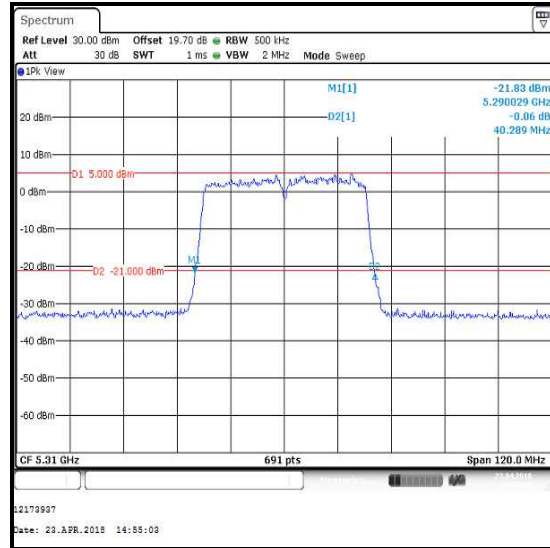
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5270	40.810
Top	5310	40.810

**Bottom Channel****Top Channel**

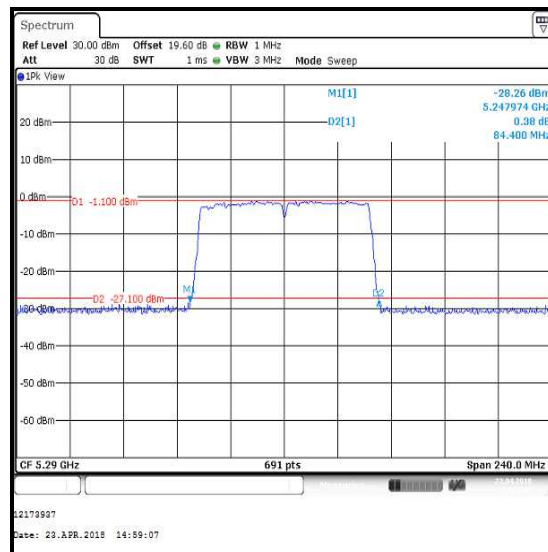
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 40 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5270	40.289
Top	5310	40.289

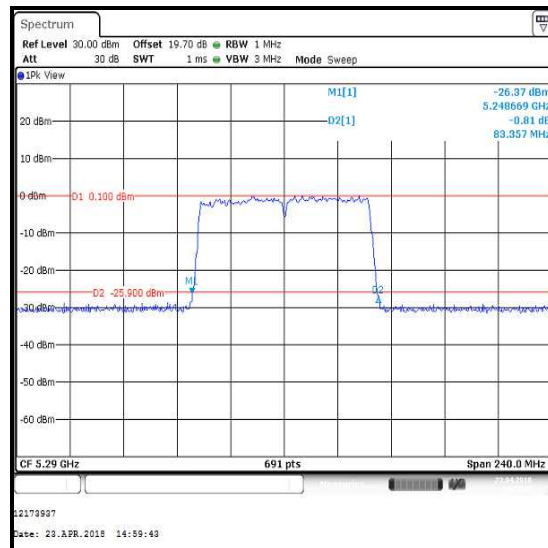
**Bottom Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11ac / 80 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF1**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5290	84.400

**Single Channel****Results: 802.11ac / 80 MHz / MIMO / 2Tx CDD / BPSK / MCS0 / Port WF3**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5290	83.357

**Single Channel**