



# TEST REPORT

**Test Report No. : UL-RPT-RP13041774JD09C V2.0**

**Customer** : Apple Inc.

**Model No.** : A2251

**FCC ID** : BCGA2251

**Technology** : WLAN

**Test Standard(s)** : FCC Parts 15.209(a) & 15.407

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

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
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:** 06 April 2020

**Checked by:**

Sarah Williams  
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**Company Signatory:**

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## **UL VS LTD**

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## Customer Information

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<b>Contact Name:</b>	Stuart Thomas

## Report Revision History

<b>Version Number</b>	<b>Issue Date</b>	<b>Revision Details</b>	<b>Revised By</b>
1.0	12/03/2020	Initial Version	Sarah Williams
2.0	06/04/2020	Antenna gains for U-NII 2C updated	Sarah Williams

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

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

The Equipment Under Test (EUT) was a Laptop Computer with *Bluetooth*, *Bluetooth Low Energy* and 802.11 a/b/g/n/ac capabilities in the 2.4 GHz and 5.0 GHz bands.

### **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>	621311
<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>	23 October 2019 to 10 January 2020

### **1.3. Summary of Test Results**

<b>FCC Reference (47CFR)</b>	<b>Measurement</b>	<b>Result</b>
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	X
Site 2	-
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)

## **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".

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Duty Cycle	5.15 GHz to 5.850 GHz	95%	$\pm 1.14 \%$
26 dB Emission Bandwidth	5.15 GHz to 5.850 GHz	95%	$\pm 4.59 \%$
Minimum 6 dB Emission Bandwidth	5.15 GHz to 5.850 GHz	95%	$\pm 4.59 \%$
Maximum Conducted Output Power	5.15 GHz to 5.850 GHz	95%	$\pm 1.13 \text{ dB}$
Maximum Power Spectral Density	5.15 GHz to 5.850 GHz	95%	$\pm 1.13 \text{ dB}$
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	$\pm 3.30 \text{ dB}$
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	$\pm 2.94 \text{ dB}$

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**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2004	Thermohygrometer	Testo	608-H1	45046425	06 Jan 2020	12
M2033	Signal Analyser	Rohde & Schwarz	FSV13	101667	29 Jan 2020	12
A3027	Attenuator	Broadwave Technologies	351-311-006	#1	Calibrated before use	-
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
A3180	Attenuator	Pasternack	PE7047-3	Not stated	Calibrated before use	-
G0615	Signal Generator	Rohde & Schwarz	SMBV100A	260473	08 May 2020	36
A3005	Replay Test Rack	N/A	N/A	N/A	Calibration not required	-

### **Test Measurement Software/Firmware Used**

Name	Version	Release Date
UL VS LTD Replay	20190208	08 February 2019

**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)
M2040	Thermohygrometer	Testo	608-H1	45124934	07 Jan 2021	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
A3154	Pre-Amplifier	Com-Power	PAM-103	18020012	04 Oct 2020	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	09 Oct 2020	12
A553	Antenna	Chase	CBL6111A	1593	14 Oct 2020	12
A3138	Antenna	Schwarzbeck	BBHA 9120 B	00702	04 Oct 2020	12
A3112	Attenuator	AtlanTecRF	AN18-06	219706#2	14 Oct 2020	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	04 Mar 2020	12
A3085	Low Pass Filter	AtlanTecRF	AFL-02000	18051600014	09 Apr 2020	12
M2003	Thermohygrometer	Testo	608-H1	45046641	07 Jan 2021	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Aug 2020	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	12 Nov 2020	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	08 Aug 2020	12
A3142	Pre Amplifier	Schwarzbeck	BBV 9718 B	00020	08 Aug 2020	12
A2893	Pre Amplifier	Schwarzbeck	BBV 9721	9721 - 023	08 Feb 2020	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	08 Aug 2020	12
A2980	Antenna	Schwarzbeck	HWRD 750	014	08 Aug 2020	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-727	08 Feb 2020	12
A2916	Attenuator	AtlanTechRF	AN18W5-10	832827#1	20 Feb 2020	12
A2914	Low Pass Filter	AtlanTecRF	AFL-04000	2156	20 Feb 2020	12
A3014	High Pass Filter	AtlanTecRF	AFH-06000	17042400007	20 Feb 2020	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	20 Feb 2020	12

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	07 Jan 2021	12
K0001	3m RSE Chamber	Rainford	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
A3179	Pre-Amplifier	Hewlett Packard	8449B	3008A00934	09 Oct 2020	12
A3138	Antenna	Schwarzbeck	BBHA 9120B	00702	04 Oct 2020	12
A2523	Attenuator	AtlanTechRF	AN18W5-10	832827#1	04 Mar 2020	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	01 Aug 2020	12
M2003	Thermohygrometer	Testo	608-H1	45046641	07 Jan 2021	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	12 Nov 2020	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	08 May 2020	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	08 Aug 2020	12
A2889	Antenna	Schwarzbeck	BBHA 9120B	BBHA 9120 B653	08 Aug 2020	12
A2916	Attenuator	AtlanTechRF	AN18W5-10	832827#1	20 Feb 2020	12

**Test Measurement Software/Firmware Used**

Name	Version	Release Date
UL VS LTD Replay	1	29 November 2018

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

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

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A2251
<b>Test Sample Serial Number:</b>	C02ZH007P1YX <i>(Conducted sample #1)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	19C19
<b>FCC ID:</b>	BCGA2251

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A2251
<b>Test Sample Serial Number:</b>	C02ZG00UP22J <i>(Radiated sample #1)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	19C19
<b>FCC ID:</b>	BCGA2251

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A2251
<b>Test Sample Serial Number:</b>	C02ZG00KP22J <i>(Radiated sample #2)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	19C19
<b>FCC ID:</b>	BCGA2251

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A2251
<b>Test Sample Serial Number:</b>	C02ZG00FP22J <i>(Radiated sample #3)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	19C19
<b>FCC ID:</b>	BCGA2251

<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A2251
<b>Test Sample Serial Number:</b>	C02ZH00BP1YX <i>(Radiated sample #4)</i>
<b>Hardware Version:</b>	REV 1.0
<b>Software Version:</b>	19C19
<b>FCC ID:</b>	BCGA2251

### **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 Mbps
	802.11n HT20	MCS0 to MCS7 (SISO)
	802.11n HT40	MCS0 to MCS7 (SISO)
	802.11ac VHT20	MCS0 to MCS8 (SISO)
	802.11ac VHT40	MCS0 to MCS9 (SISO)
	802.11ac VHT80	MCS0 to MCS9 (SISO)
<b>Power Supply Requirement(s):</b>	Nominal	Constant 3.8 VDC via 120 VAC 60 Hz AC/DC supply
<b>Maximum Conducted Output Power:</b>	20 MHz	14.2 dBm
	40 MHz	14.1 dBm
	80 MHz	14.2 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>	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	36	5180
	Middle	40	5200
	Top	48	5240
<b>Transmit Frequency Band:</b>	5250 MHz to 5350 MHz		
<b>Transmit Channels Tested:</b>	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	52	5260
	Middle	56	5280
	Top	64	5320
<b>Transmit Frequency Band:</b>	5470 MHz to 5725 MHz		
<b>Transmit Channels Tested:</b>	Channel ID	Channel Number	Channel Frequency (MHz)
	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>	Channel ID	Channel Number	Channel Frequency (MHz)
	Single	144	5720
<b>Transmit Frequency Band:</b>	5725 MHz to 5850 MHz		
<b>Transmit Channels Tested:</b>	Channel ID	Channel Number	Channel Frequency (MHz)
	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 an integrated antenna, with the following maximum gains:

Frequency Range (MHz)	Antenna Gain (dBi)
5150 to 5250	4.0
5250 to 5350	3.3
5470 to 5725	3.0
5725 to 5850	3.0

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

#### **Support Equipment**

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

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

<b>Description:</b>	USB-C Cable. Length 2 m.
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

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

<b>Description:</b>	USB-C to USB Adapter. Quantity 3.
<b>Brand Name:</b>	Apple
<b>Model Name or Number:</b>	A1632
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	USB Cable Type A. Quantity 3. Length 3 m.
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

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

<b>Description:</b>	USB Hub
<b>Brand Name:</b>	Hama
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	00078498

## **Operating Modes**

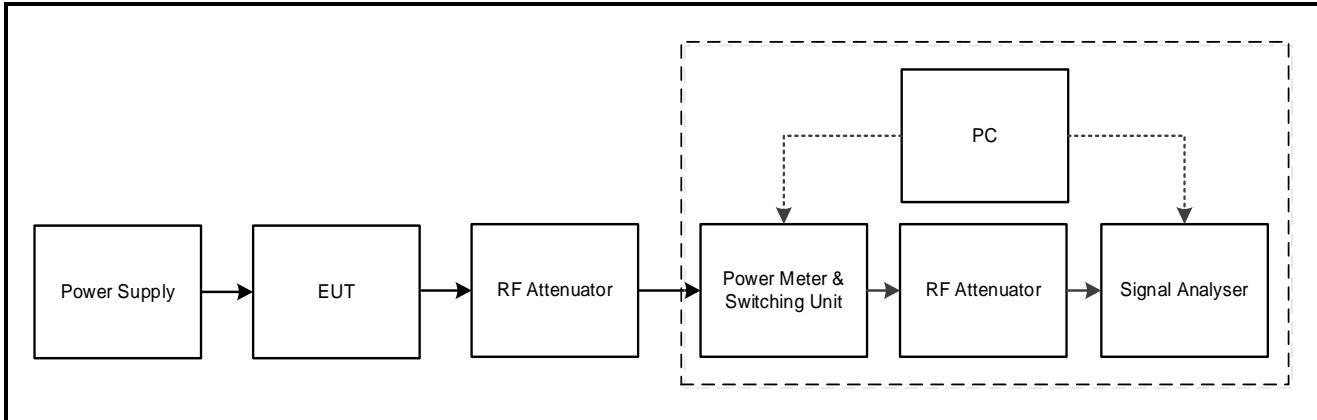
The EUT was tested in the following operating mode(s):

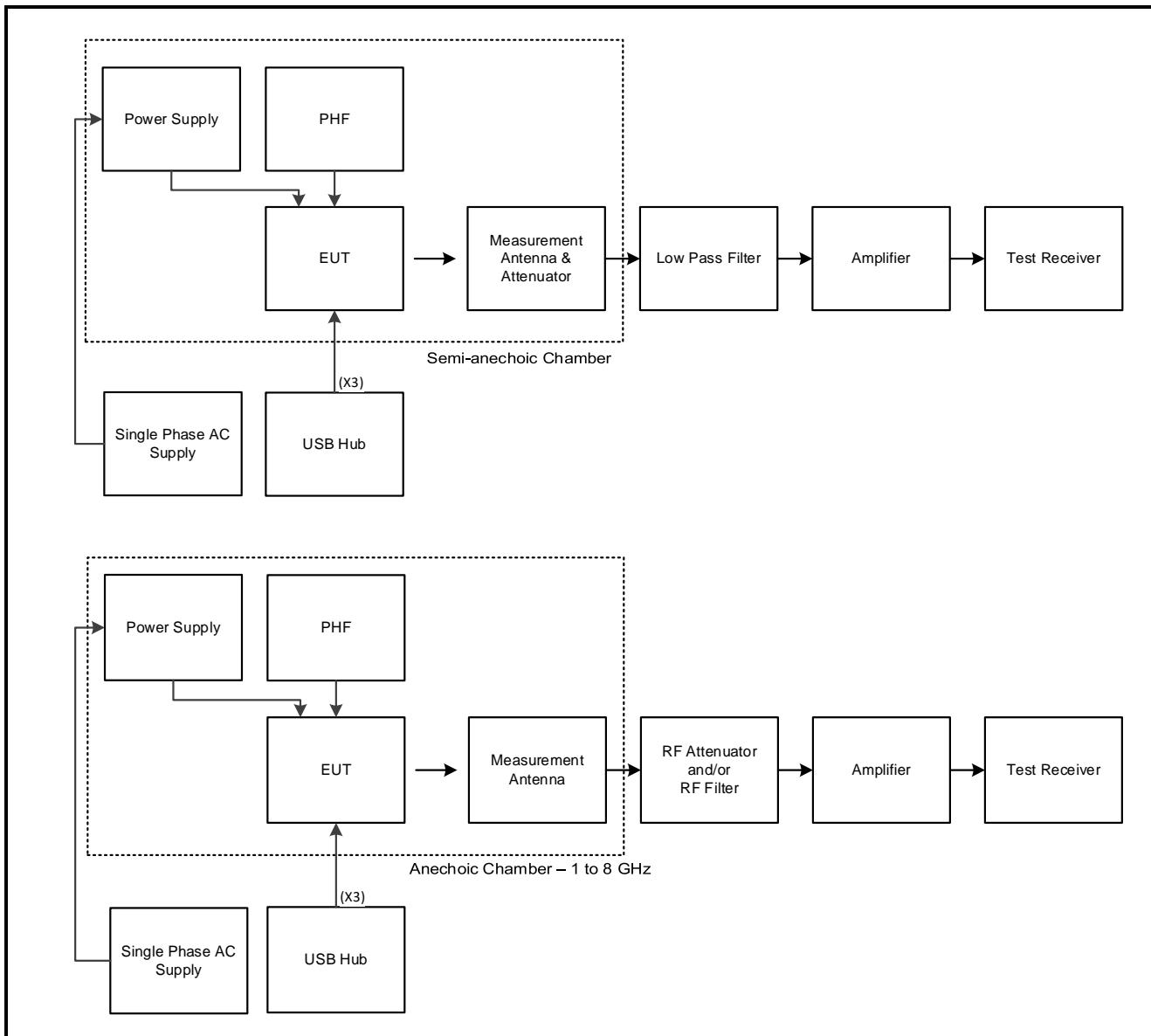
- Continuously transmitting with a modulated carrier at maximum power on the bottom, middle and top channels as required using the supported data rates/modulation types.

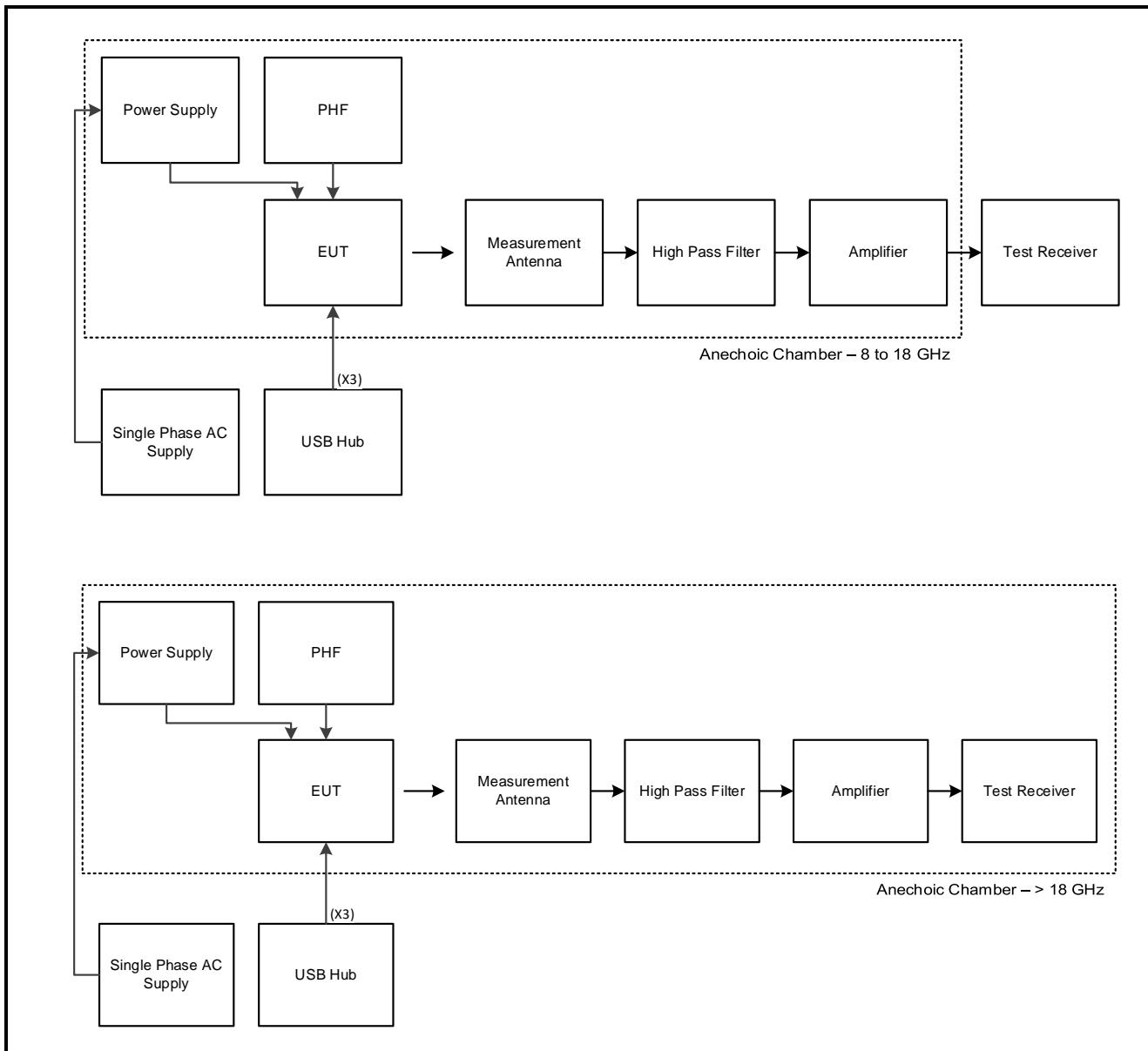
## **Configuration and Peripherals**

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 requested the following data rates to be used for all measurements.
  - 802.11a / SISO - BPSK / 6 Mbps / Core 2
  - 802.11n HT20 / SISO – BPSK / MCS0 / Core 2
  - 802.11n HT40 / SISO – BPSK / MCS0 / Core 2
  - 802.11ac VHT80 / SISO – BPSK / MCS0 / Core 2
- 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 as it procedure the worst case output power.
- Transmitter radiated spurious emissions tests were performed with the AC Charger, USB cables and PHF connected to the EUT. The USB-C ports were connected via a USB C-A adaptor and USB cable to a hub. The hub 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**

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

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

## **4. Antenna Port Test Results**

### **4.1. Transmitter Duty Cycle**

#### **Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	13 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

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

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	36

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

1. 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:

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

$$802.11n \text{ HT40 / SISO / MCS0 duty cycle: } 10 \log (1 / (1.117 / 1.141)) = 0.1$$

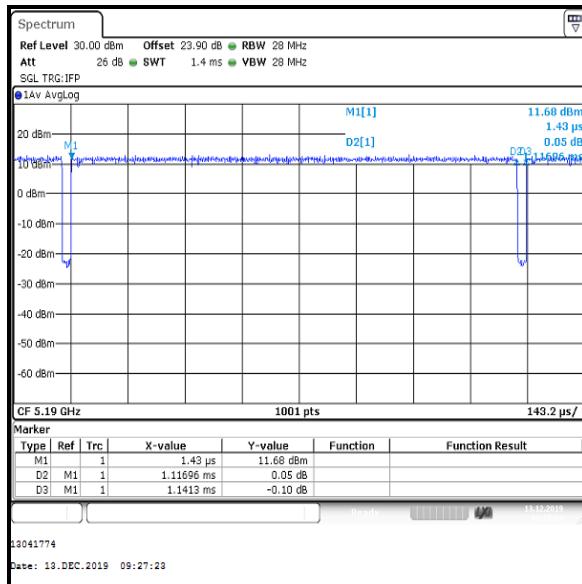
$$802.11ac \text{ VHT80 / SISO / MCS0 duty cycle: } 10 \log (1 / (0.543 / 0.566)) = 0.2$$

2. 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.
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.

## Transmitter Duty Cycle (continued)

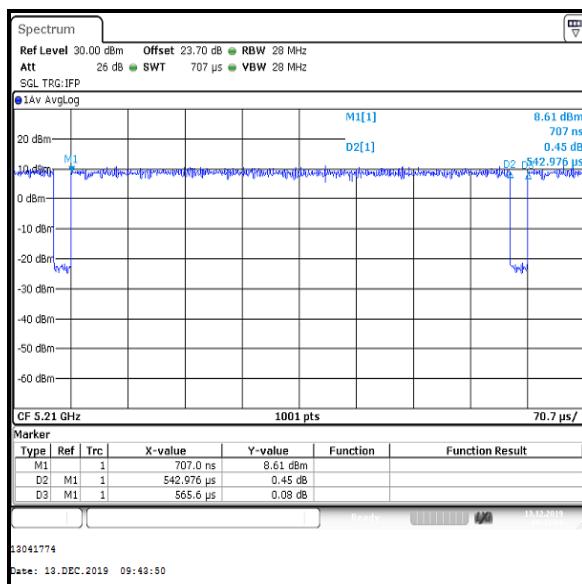
## Results: 802.11n / 40 MHz / MCS0

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
1.117	1.141	0.1



## Results: 802.11ac / 80 MHz / MCS0

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.543	0.566	0.2



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

### **Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Dates:</b>	13 December 2019 & 16 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

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

### **Environmental Conditions:**

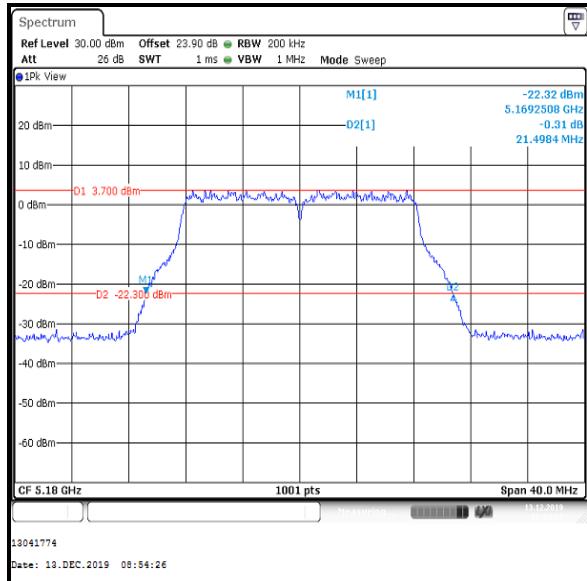
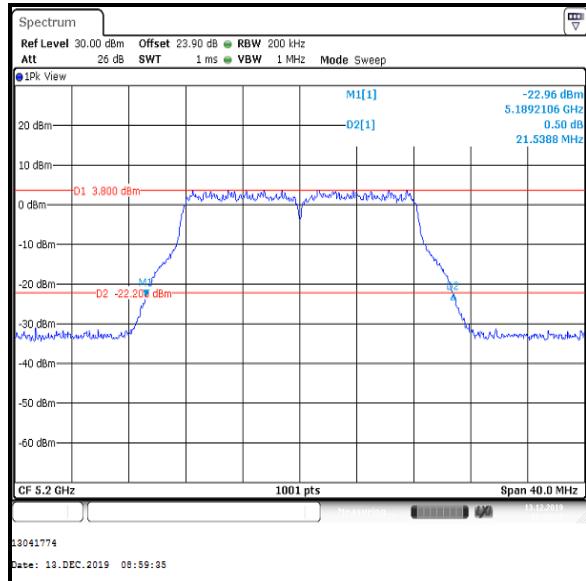
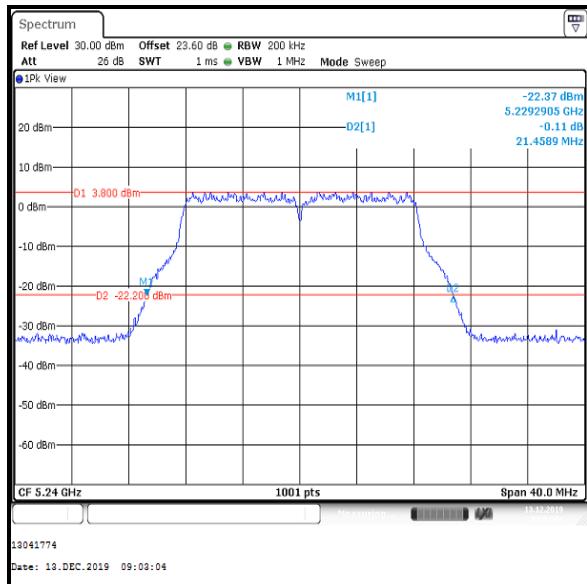
<b>Temperatures (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	36 to 38

### **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'.

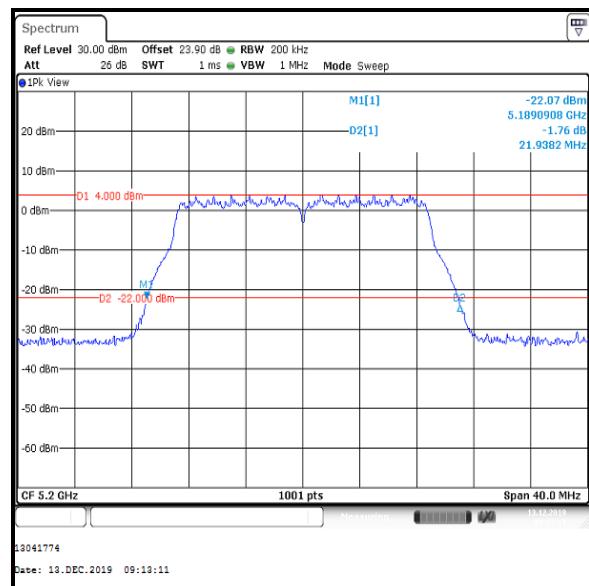
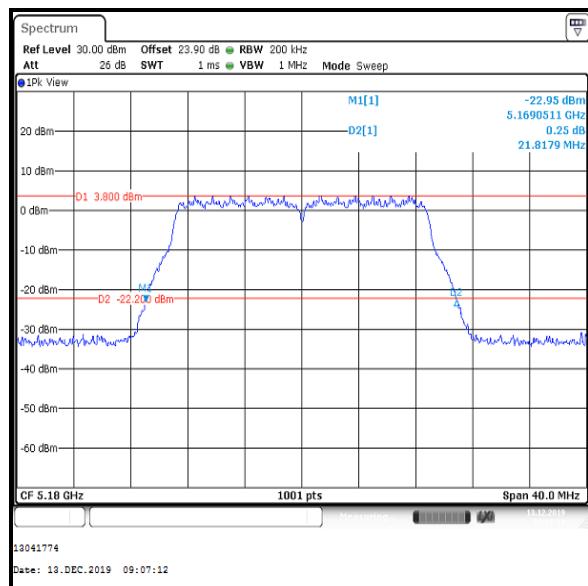
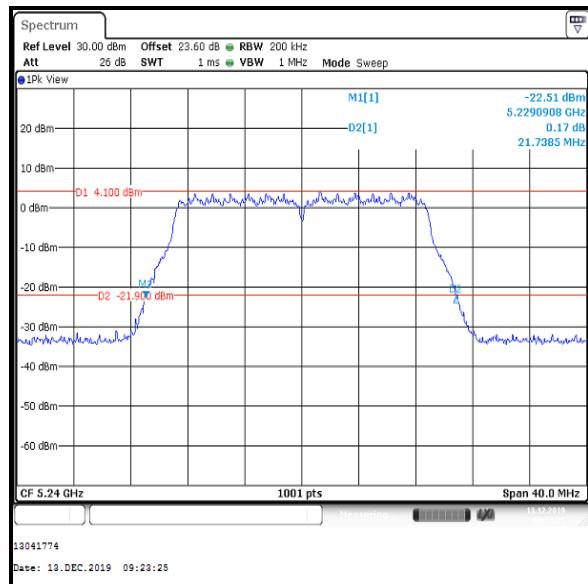
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****4.2.1. 5.15-5.25 GHz band****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.498
Middle	5200	21.539
Top	5240	21.459

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

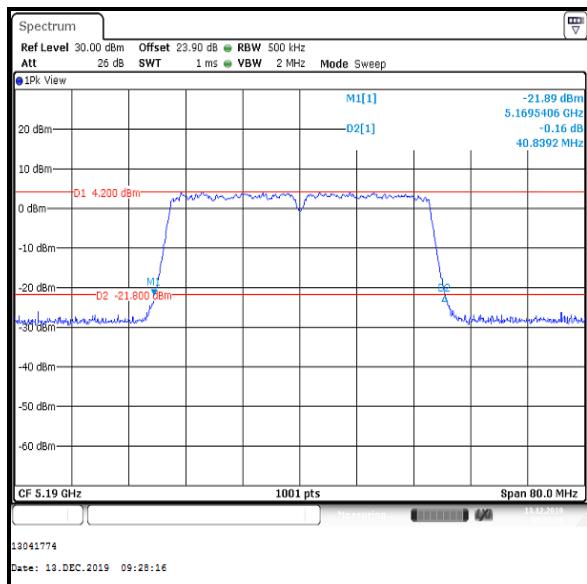
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	21.818
Middle	5200	21.938
Top	5240	21.739

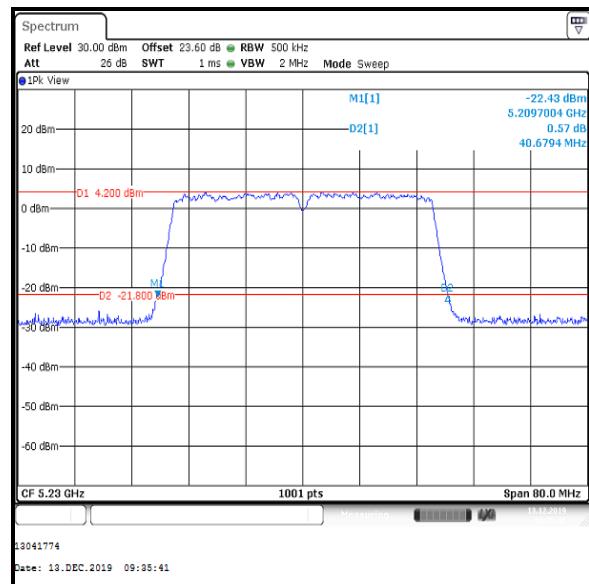
**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5190	40.839
Top	5230	40.679



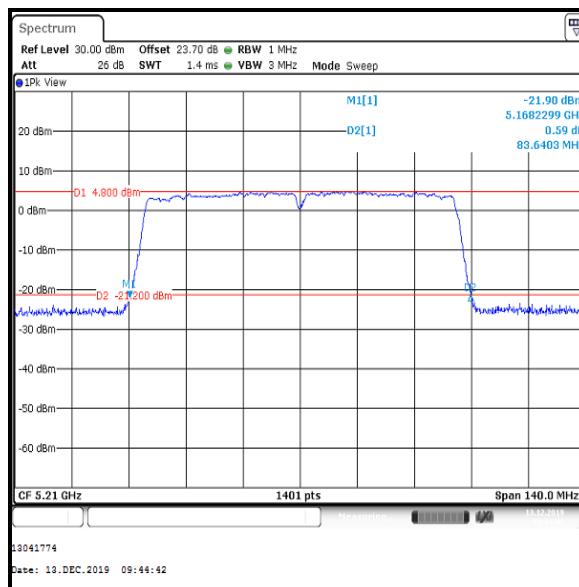
Bottom Channel



Top Channel

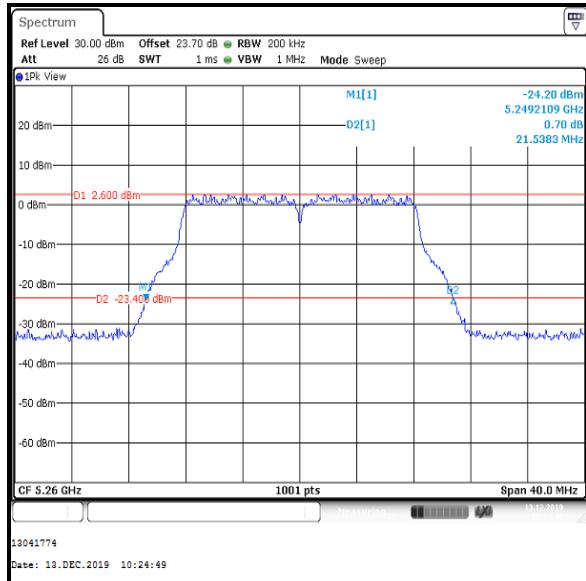
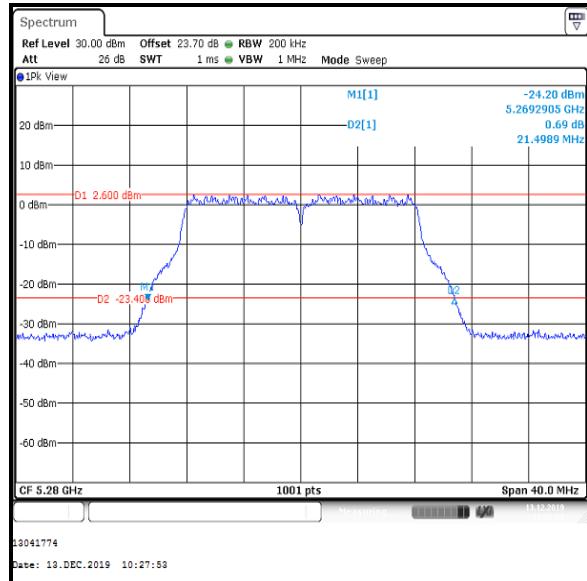
**Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5210	83.640



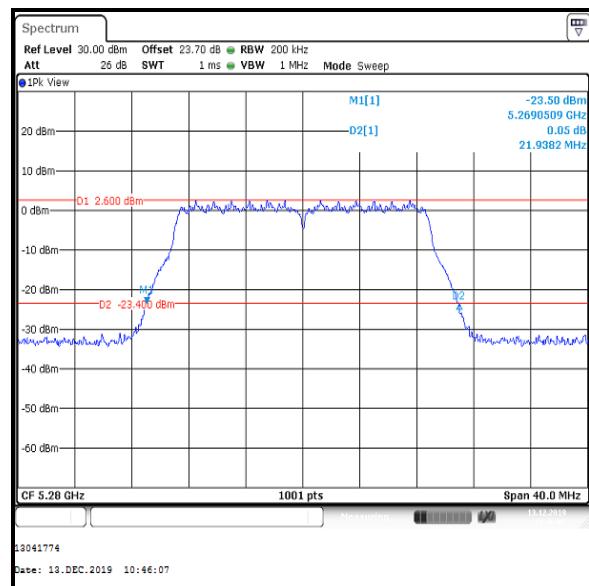
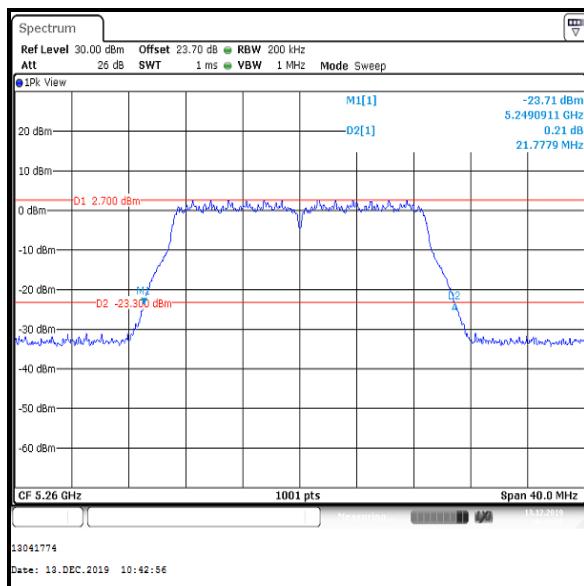
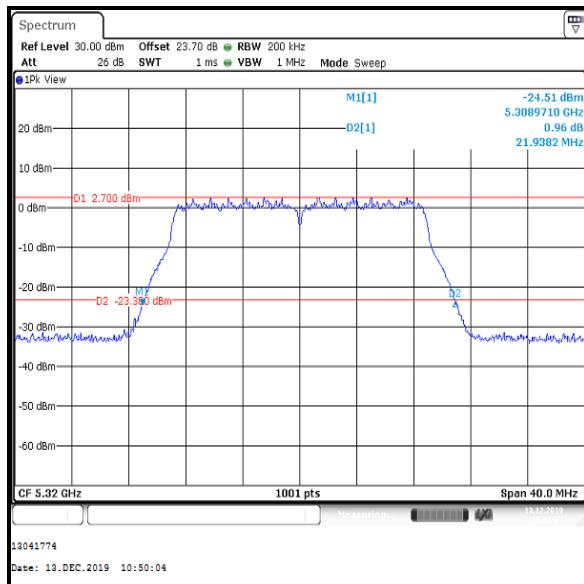
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****4.2.2. 5.25-5.35 GHz band****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	21.538
Middle	5280	21.499
Top	5320	21.539

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

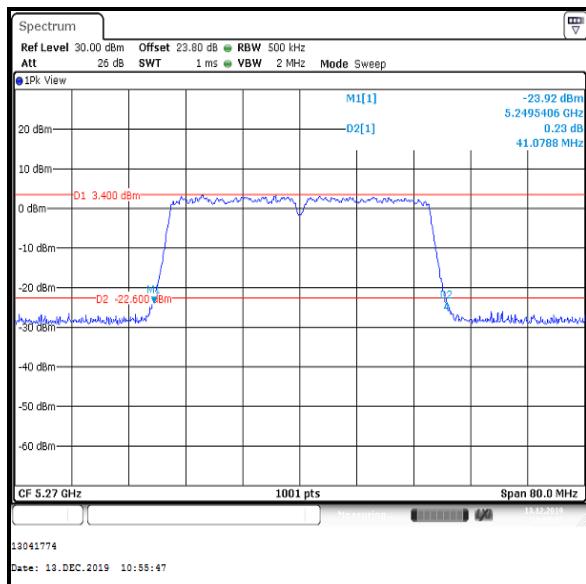
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	21.778
Middle	5280	21.938
Top	5320	21.938

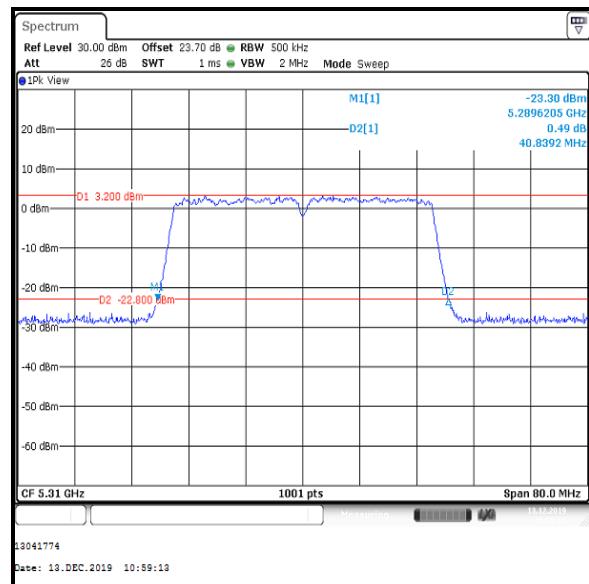
**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5270	41.079
Top	5310	40.839



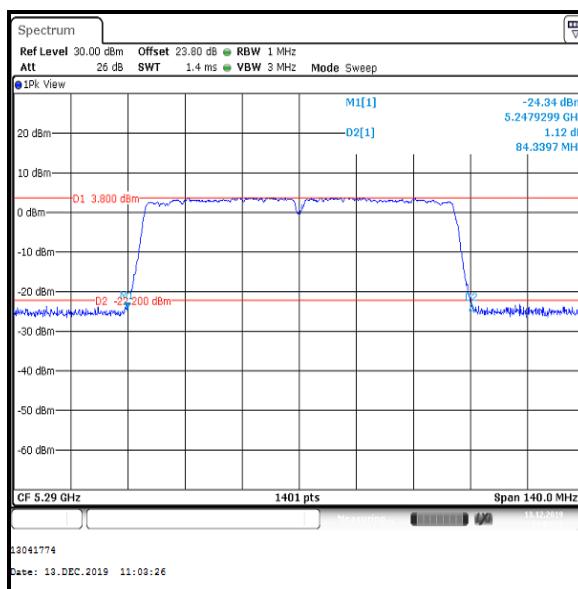
Bottom Channel



Top Channel

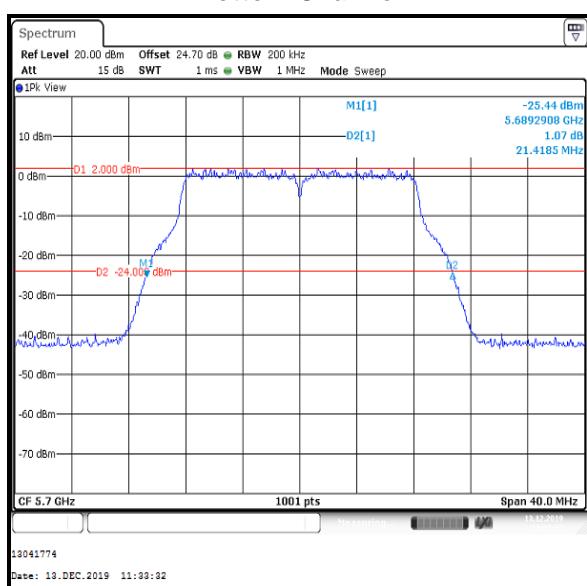
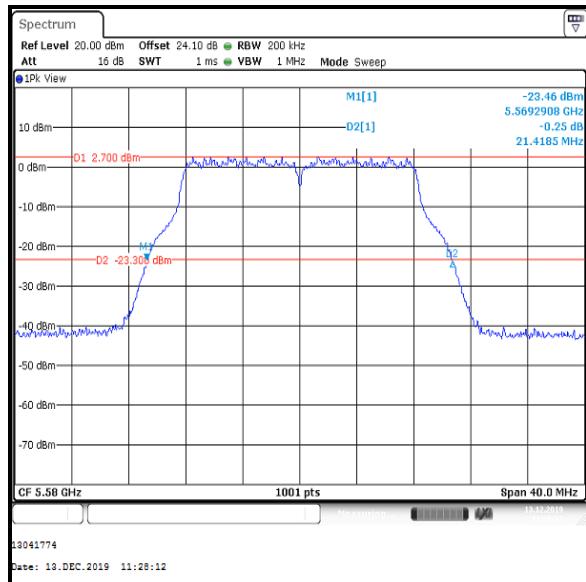
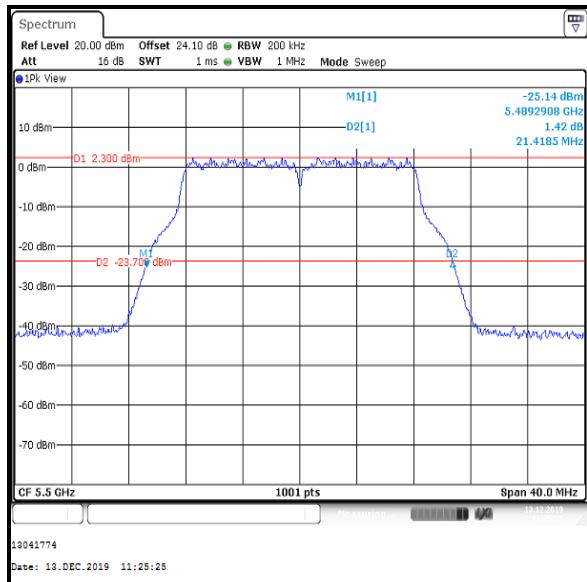
**Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5290	84.340

**Single Channel**

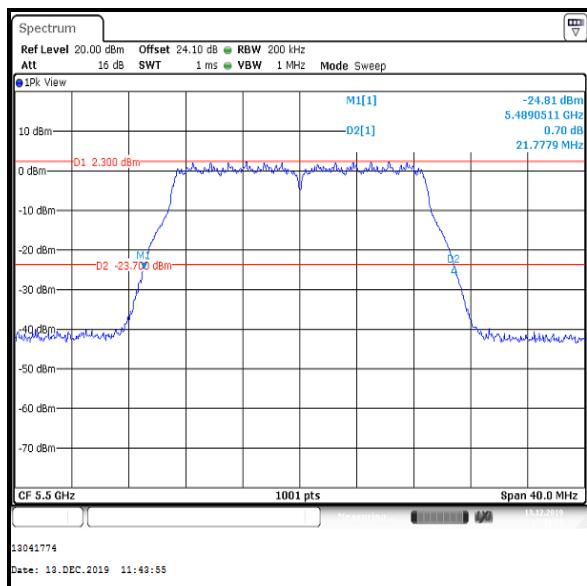
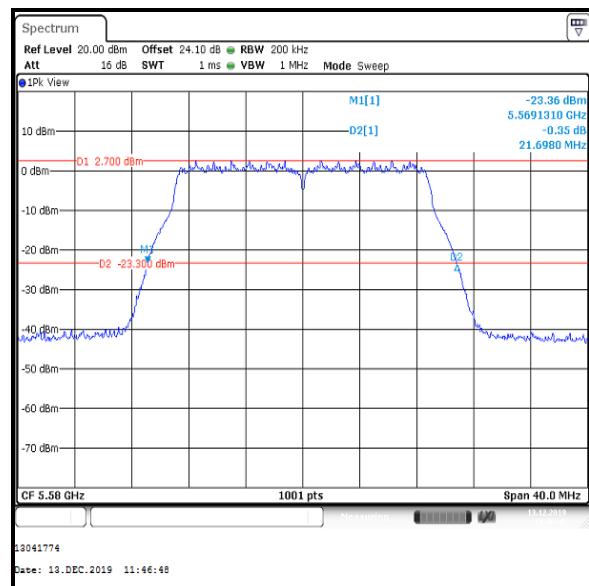
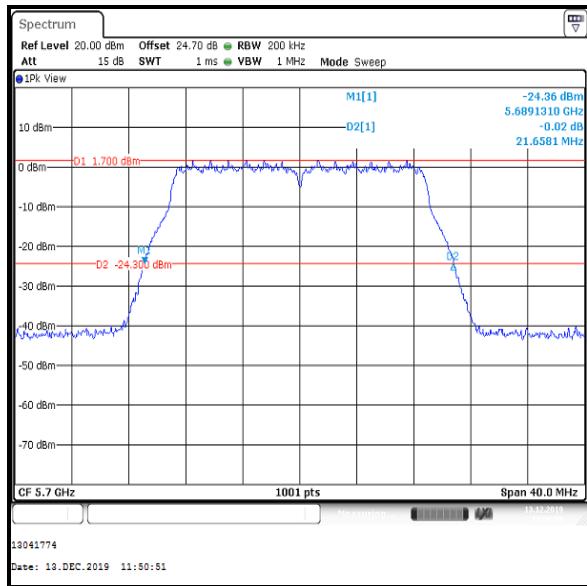
**Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band) (continued)****4.2.3. 5.47-5.725 GHz band****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5500	21.419
Middle	5580	21.419
Top	5700	21.419



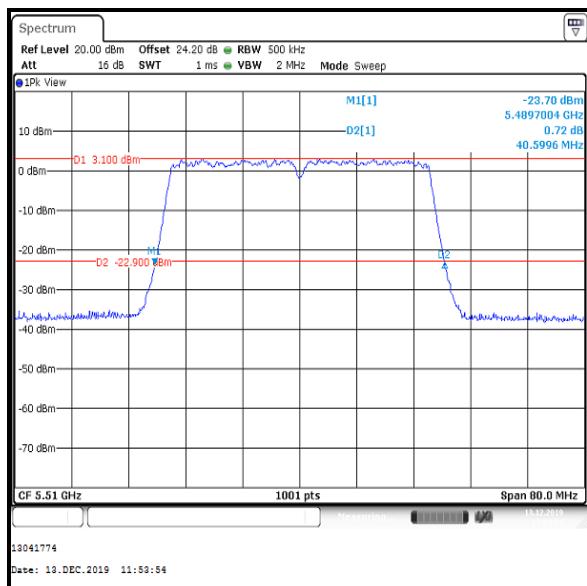
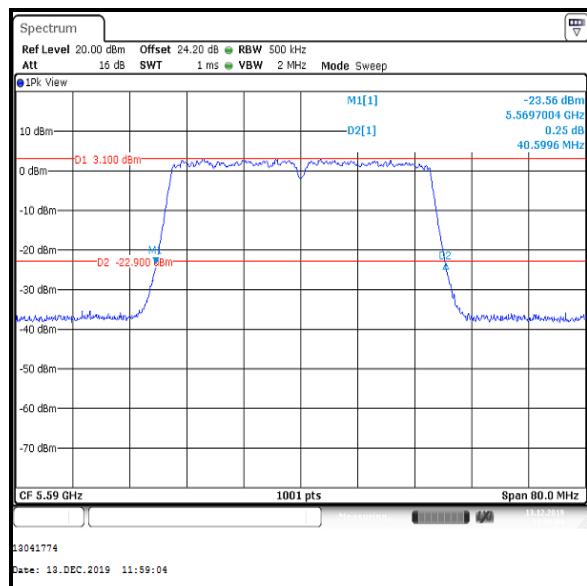
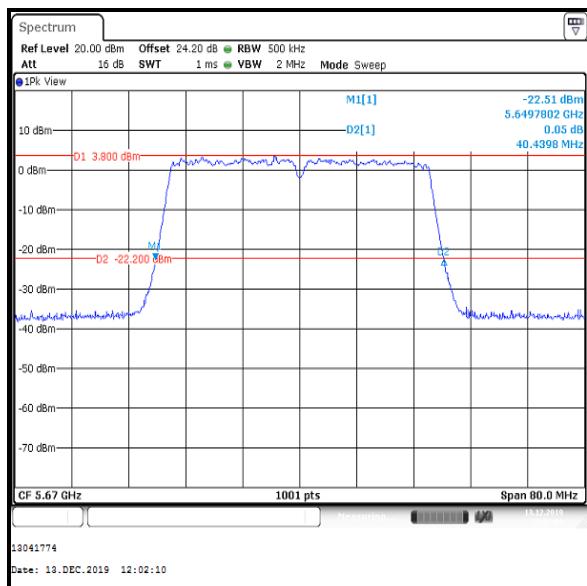
**Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5500	21.778
Middle	5580	21.698
Top	5700	21.658

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

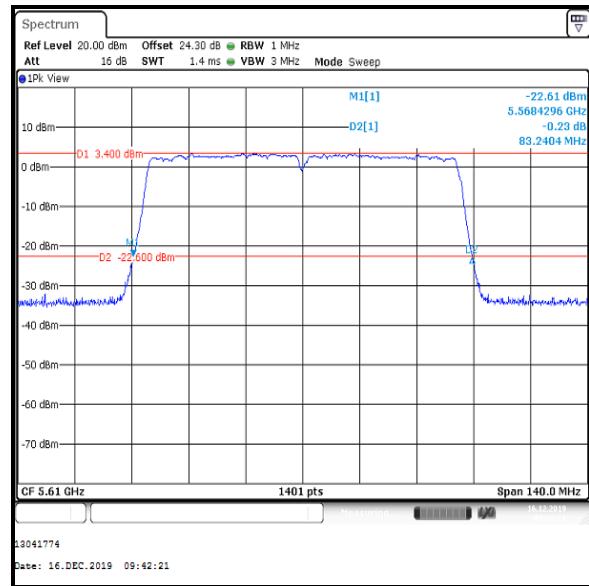
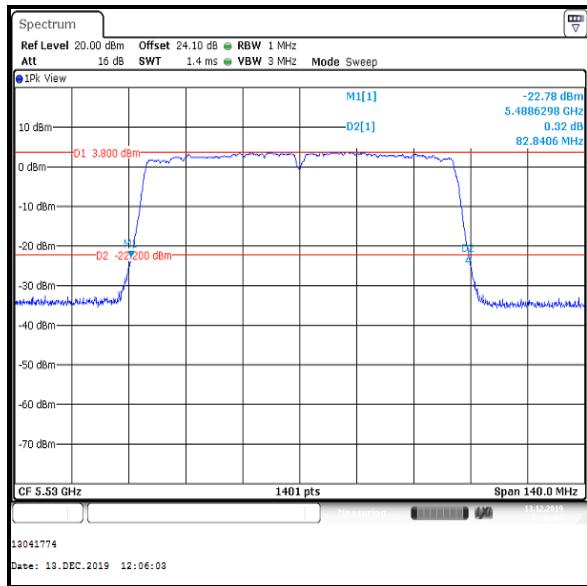
**Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5510	40.600
Middle	5590	40.600
Top	5670	40.440

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

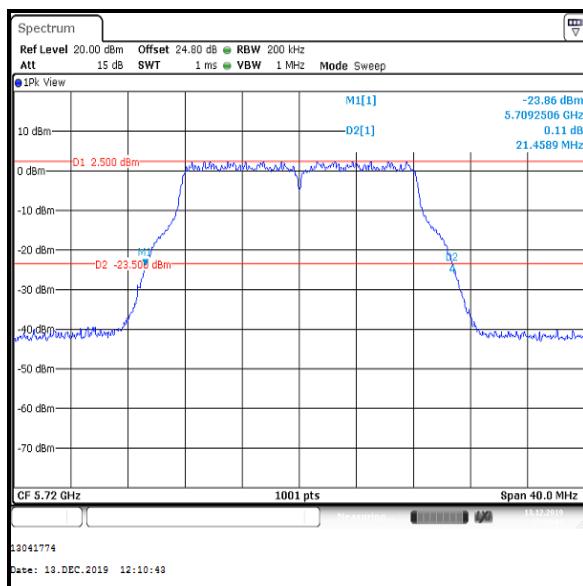
**Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5530	82.841
Top	5610	83.240

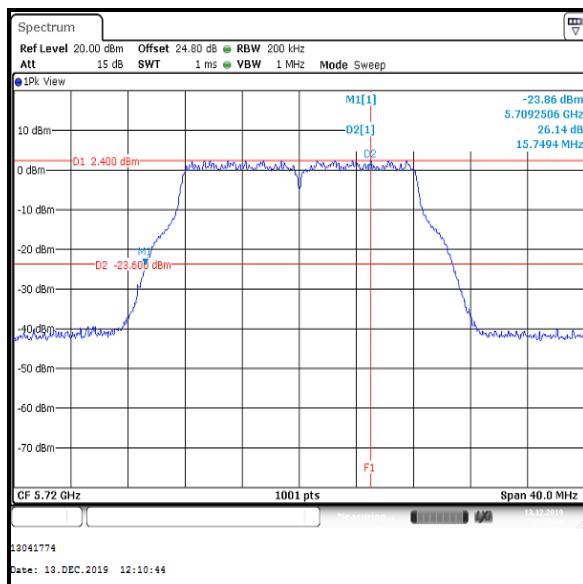


**Transmitter 26 dB Emission Bandwidth (Straddle Channels) (continued)****4.2.4. Channels that straddle the U-NII-2C and U-NII-3 bands****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5720	21.459

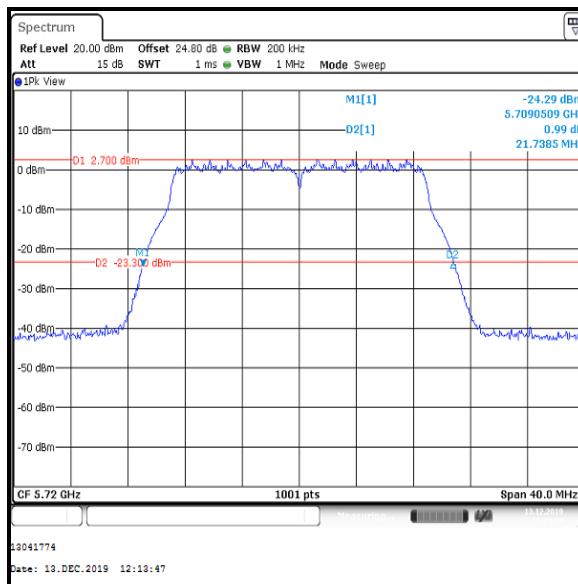
**Single Channel****Results: Reference Plots / 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5720	15.749

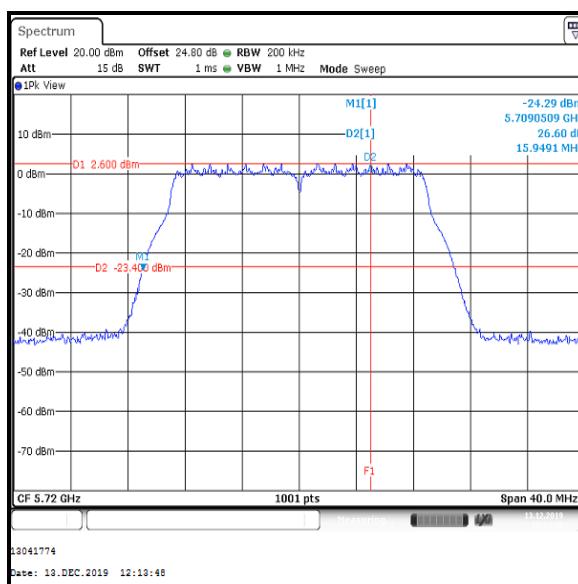
**Single Channel**

**Transmitter 26 dB Emission Bandwidth (Straddle Channels) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5720	21.739

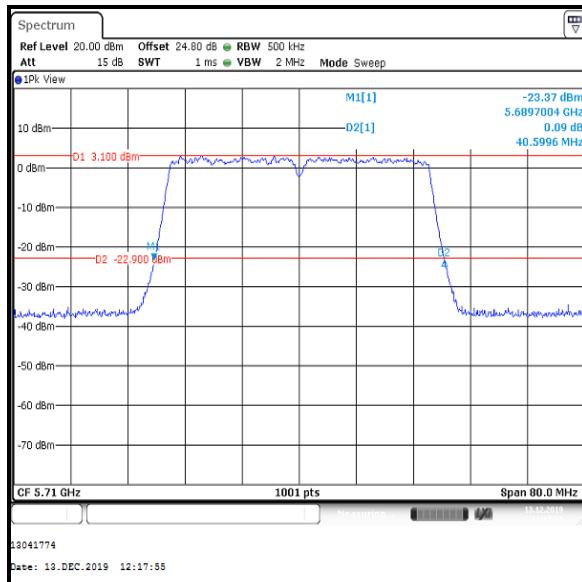
**Single Channel****Results: Reference Plots / 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5720	15.949

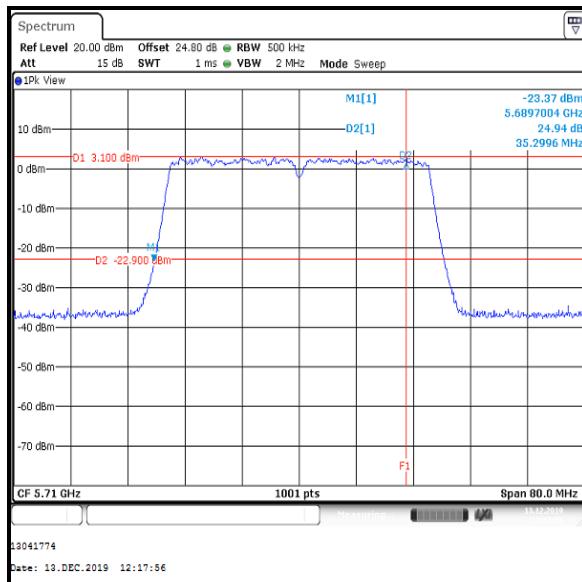
**Single Channel**

**Transmitter 26 dB Emission Bandwidth (Straddle Channels) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5710	40.600

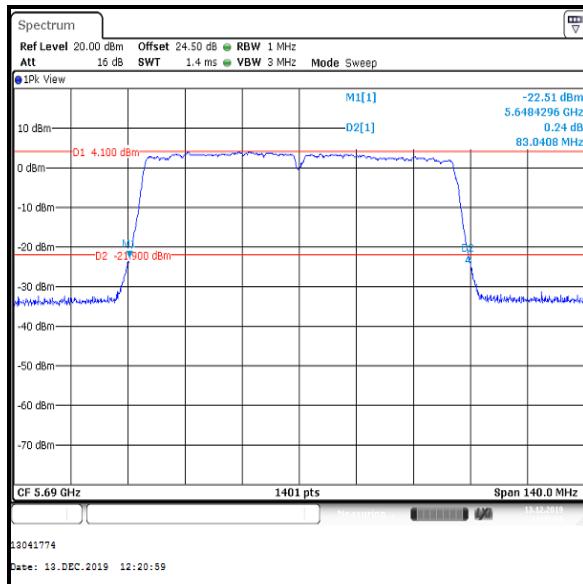
**Single Channel****Results: Reference Plots / 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5710	35.300

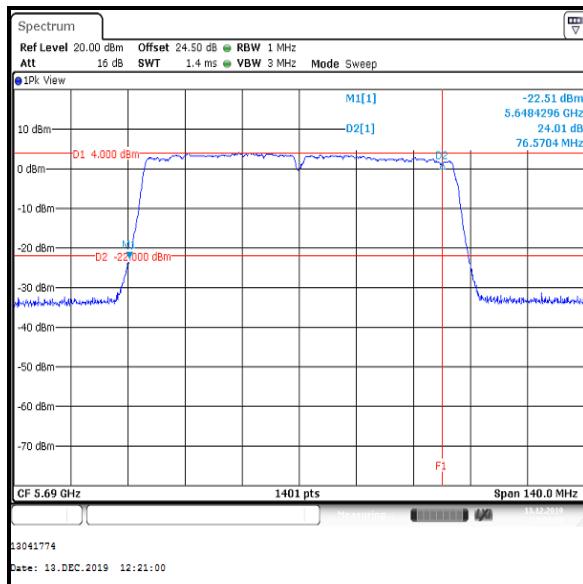
**Single Channel**

**Transmitter 26 dB Emission Bandwidth (Straddle Channels) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5690	83.041

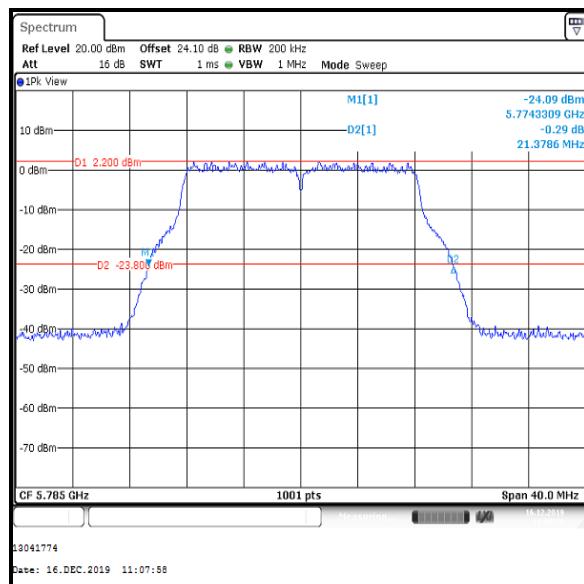
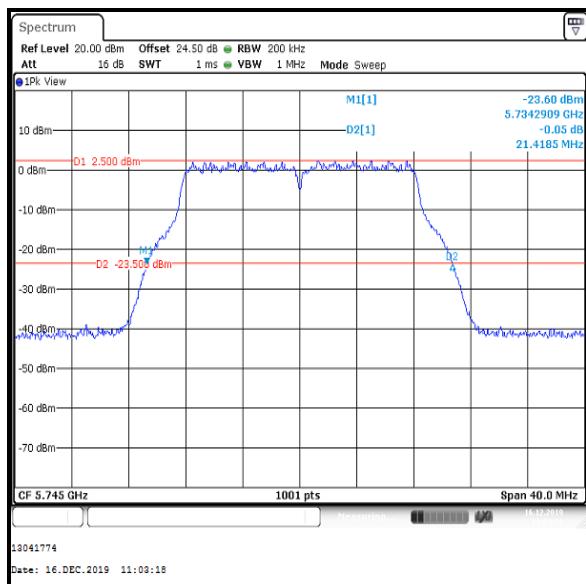
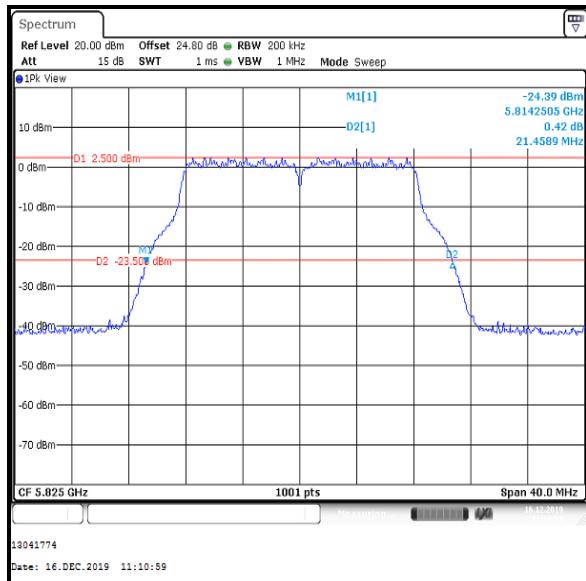
**Single Channel****Results: Reference Plots / 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5690	76.570

**Single Channel**

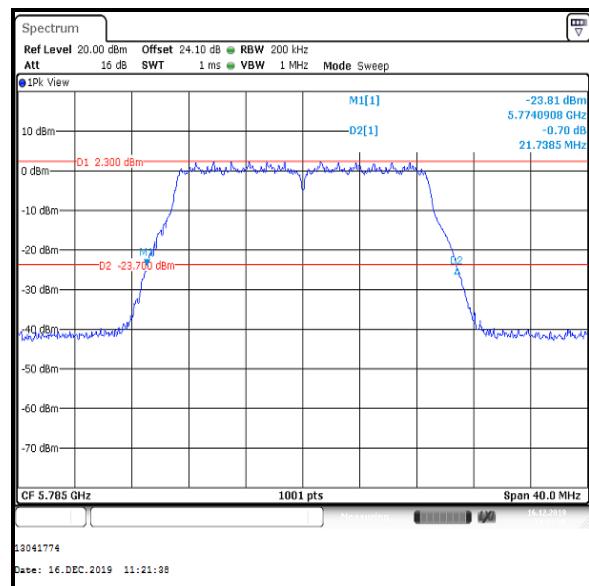
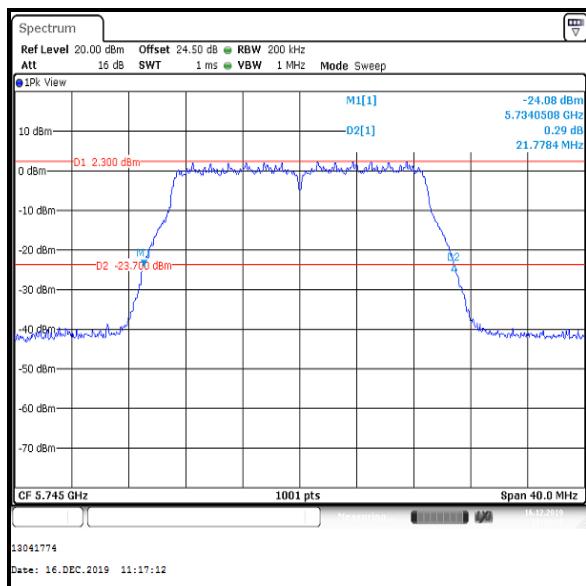
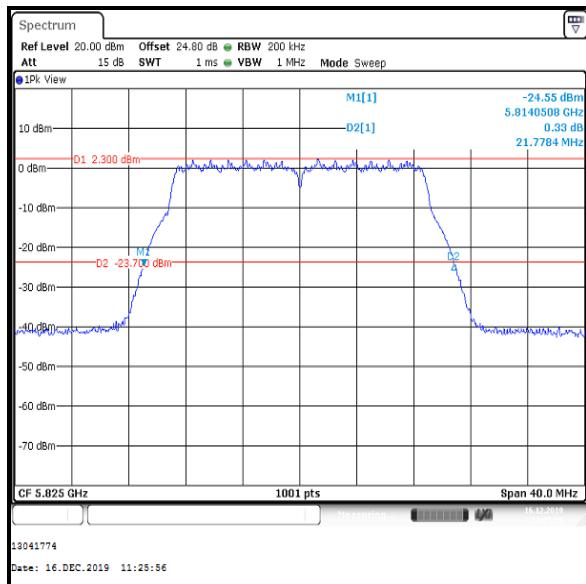
**Transmitter 26 dB Emission Bandwidth (5.725-5.85 GHz band) (continued)****4.2.5. 5.725-5.85 GHz band****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5745	21.419
Middle	5785	21.379
Top	5825	21.459

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

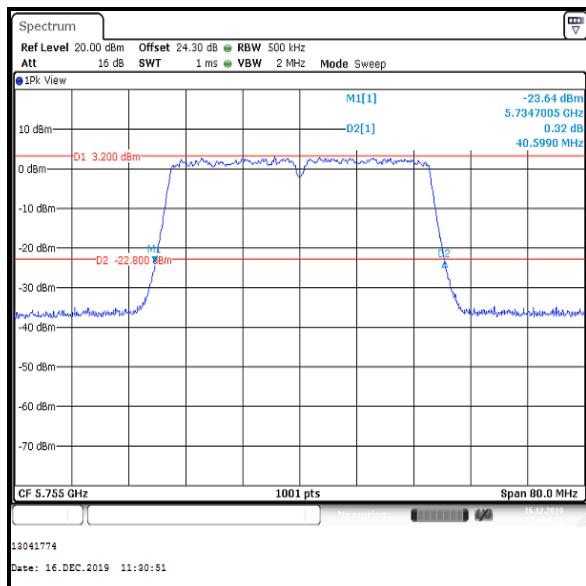
**Transmitter 26 dB Emission Bandwidth (5.725-5.85 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5745	21.778
Middle	5785	21.739
Top	5825	21.778

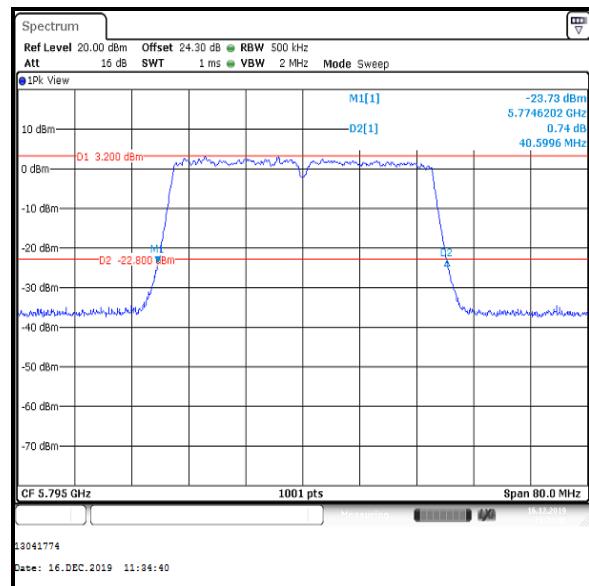
**Bottom Channel****Middle Channel****Top Channel**

**Transmitter 26 dB Emission Bandwidth (5.725-5.85 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5755	40.599
Top	5795	40.600



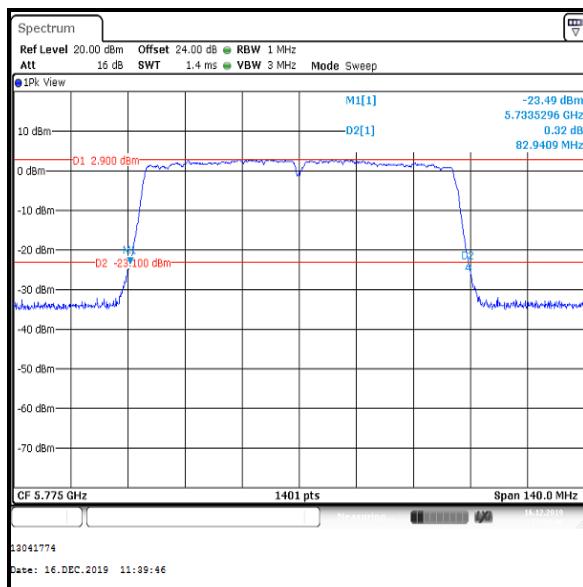
Bottom Channel



Top Channel

**Transmitter 26 dB Emission Bandwidth (5.725-5.85 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Single	5775	82.941

**Single Channel**

**4.3. Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band)****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Dates:</b>	13 December 2019 & 16 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(e)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.C.2.

**Environmental Conditions:**

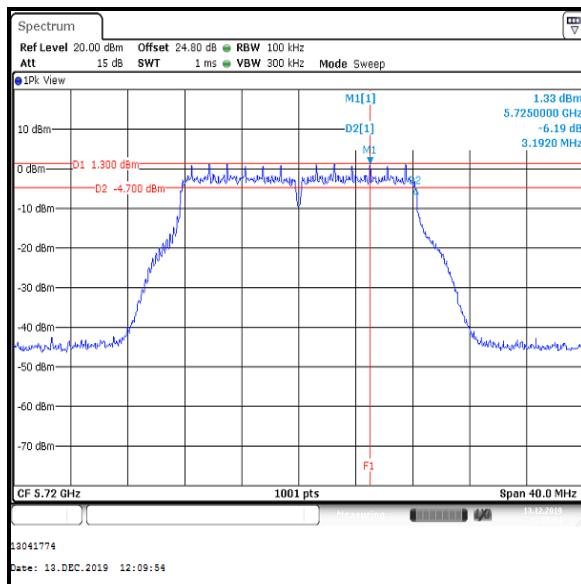
<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	36 to 38

**Note(s):**

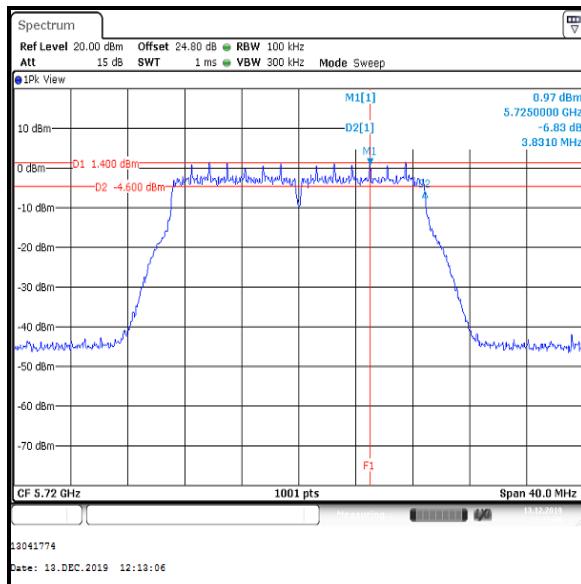
1. Measurements were performed on data rates detailed in Section 3.5 on the relevant channels.
2. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
3. For channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz, measurements were performed on the portion of the emission that is contained within the U-NII-3 band.

**Transmitter Minimum 6 dB Bandwidth (Straddle Channels) (continued)****4.3.1. Channels that straddle the U-NII-2C and the U-NII-3 bands at 5.725 GHz****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	3192	≥500	2692	Complied

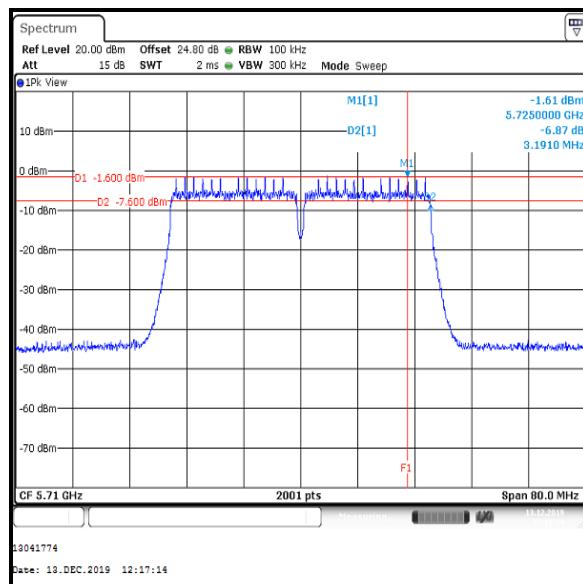
**Single Channel****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	3831	≥500	3331	Complied

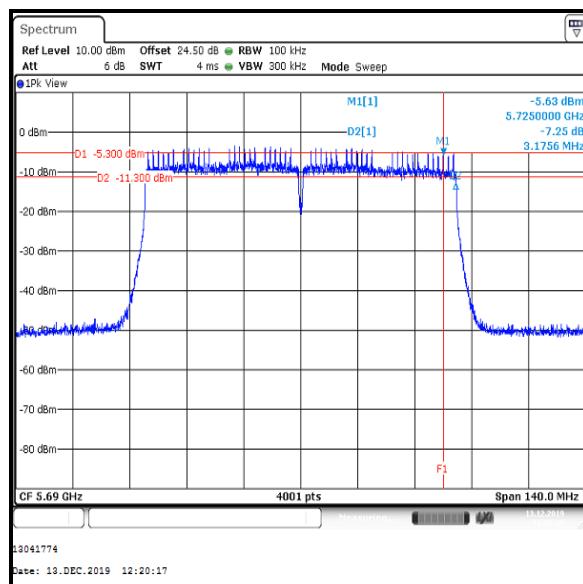
**Single Channel**

**Transmitter Minimum 6 dB Bandwidth (Straddle Channels) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	3191	≥500	2691	Complied

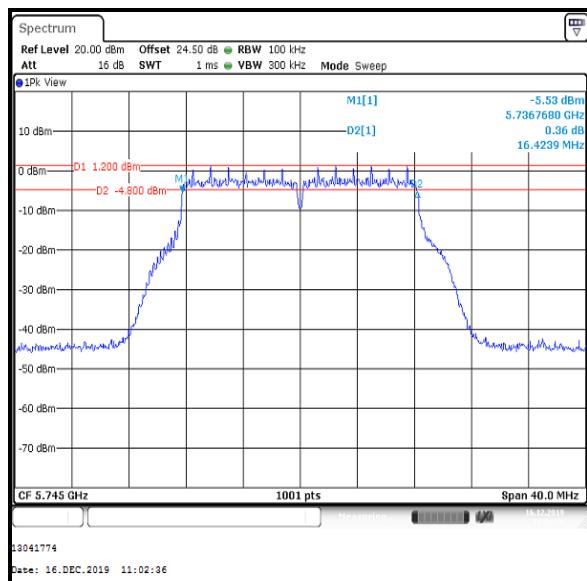
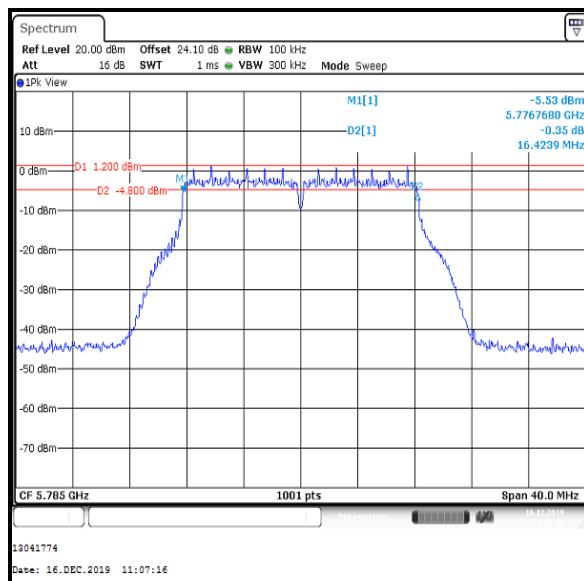
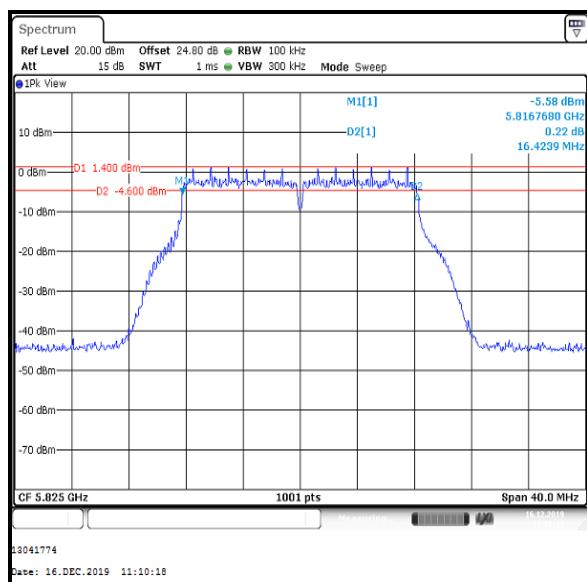
**Single Channel****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	3176	≥500	2676	Complied

**Single Channel**

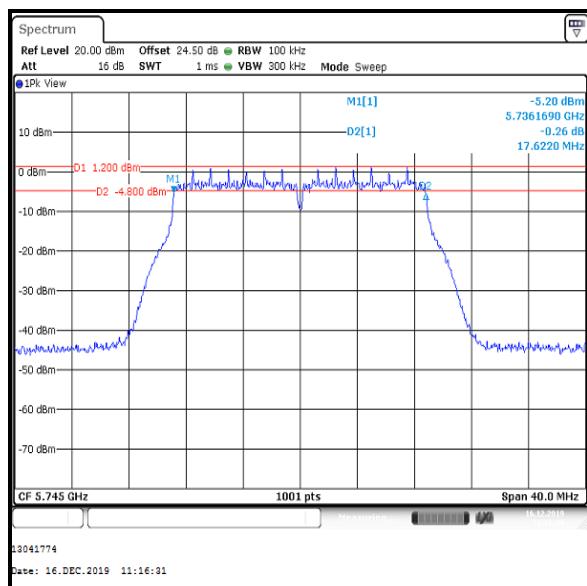
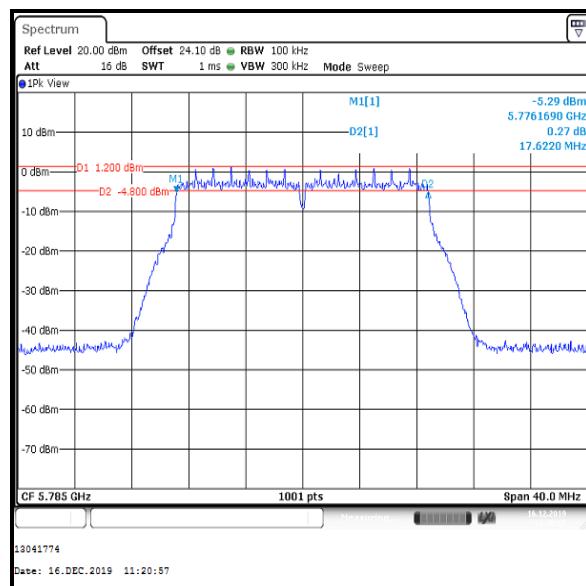
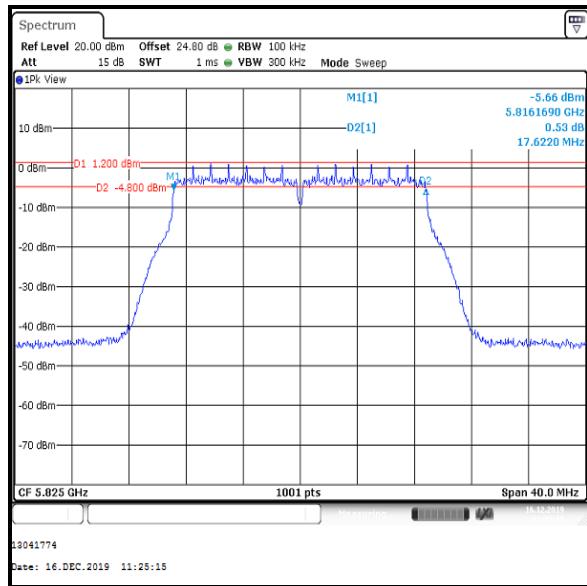
**Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)****4.3.2. 5.725-5.85 GHz band****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16424	≥500	15924	Complied
Middle	16424	≥500	15924	Complied
Top	16424	≥500	15924	Complied

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

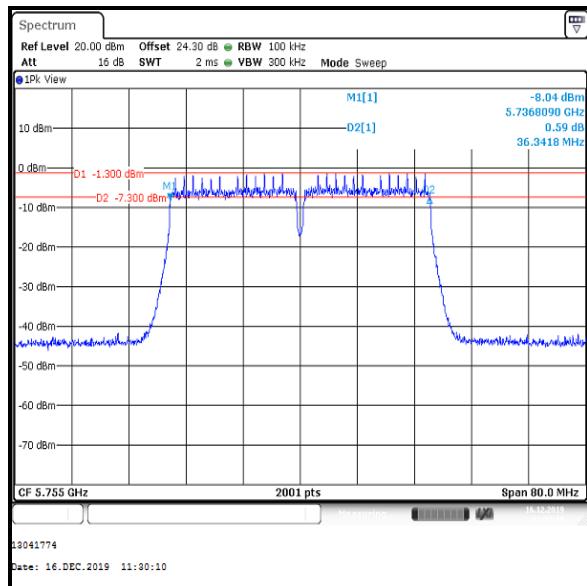
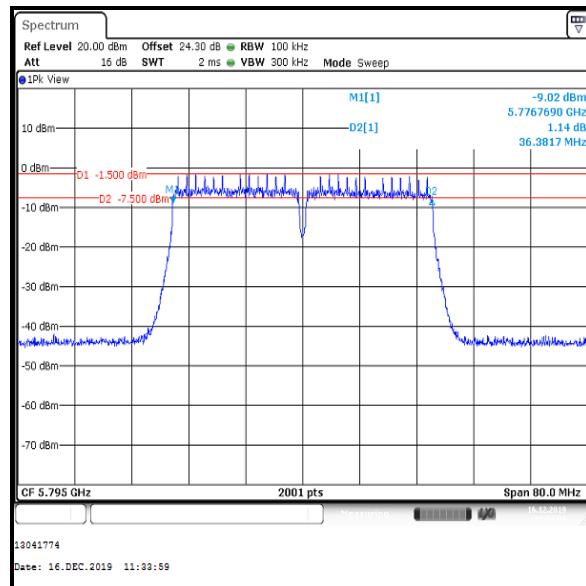
**Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17622	≥500	17122	Complied
Middle	17622	≥500	17122	Complied
Top	17622	≥500	17122	Complied

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

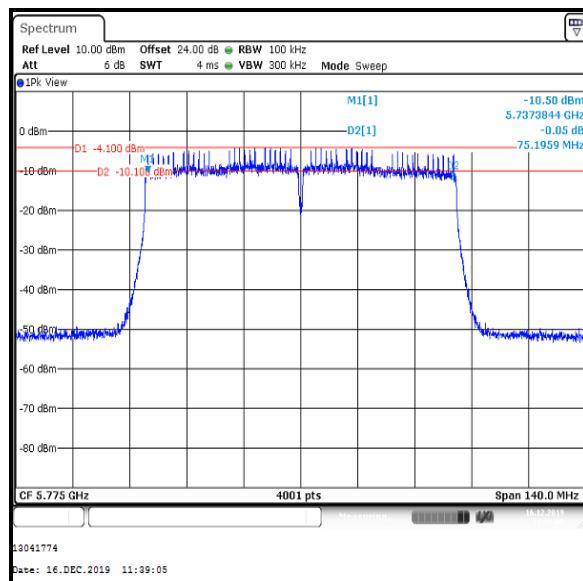
**Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	36342	≥500	35842	Complied
Top	36382	≥500	35882	Complied

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

**Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	75196	≥500	74696	Complied



## **4.4. Transmitter Maximum Conducted Output Power**

### **4.4.1. 5.15-5.25 GHz band**

#### **Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	13 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(1)(iv)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.E.2.b) and II.E.2.d)

#### **Environmental Conditions:**

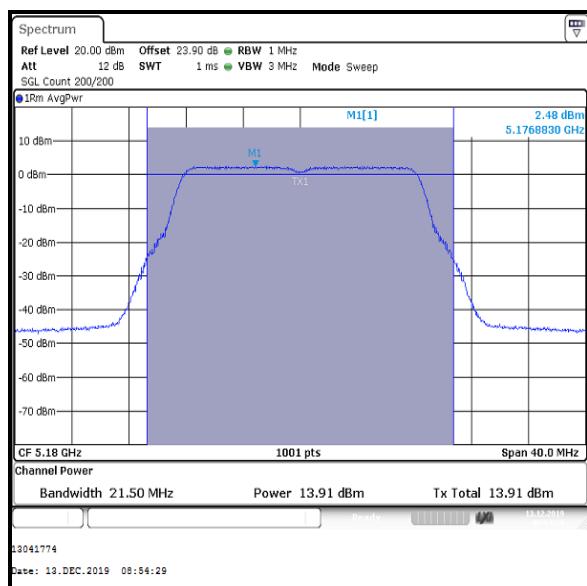
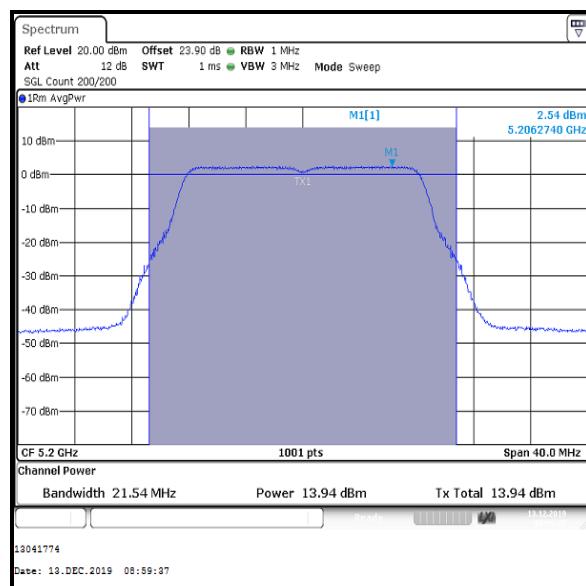
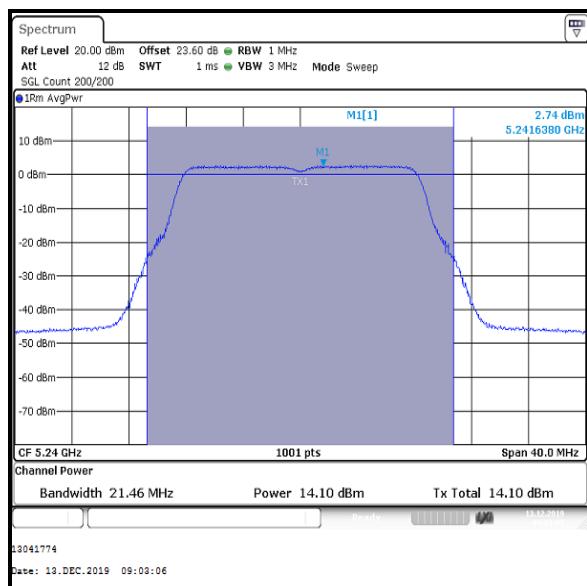
<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	36

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

1. Initial measurements were performed using a power meter to obtain the required power setting according to customer specified tolerances. This setting was then used to measure the power using the test methods listed below.
2. For conducted power tests where the duty cycle is >98%, the measurements were performed using a signal analyser in accordance with FCC KDB 789033 II.E.2.b) Method SA-1. Where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 789033 II.E.2.d) Method SA-2. The signal analyser's integration function was used to integrate across the 26 dB emission bandwidth. The resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time was set to auto and 200 traces performed. The span was set to encompass the entire 26 dB emission bandwidth. The channel power results are recorded in the tables below.
3. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
4. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured power in order to compute the average power during the actual transmission time.
5. The Part 15.407(a)(1)(iv) limit shall not exceed 250 mW (24.0 dBm).
6. For all modes of operation, the antenna gain is < 6 dBi.
7. For details on antenna gains refer to Section 3.4 of this test report.
8. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

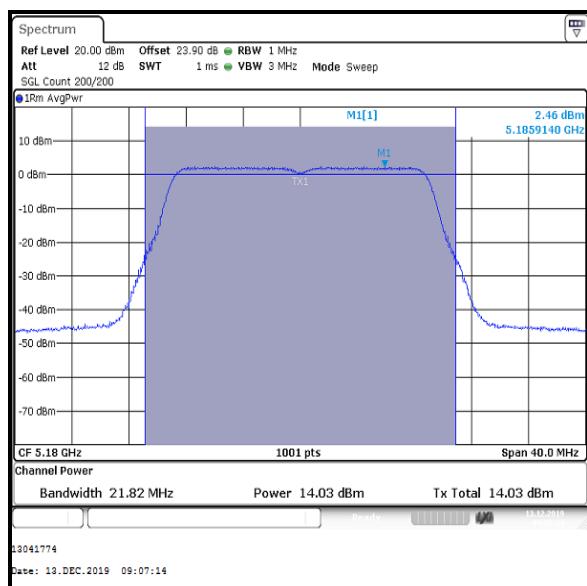
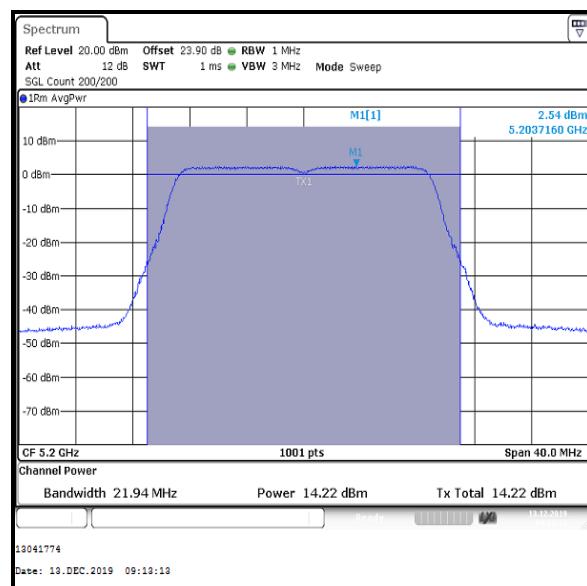
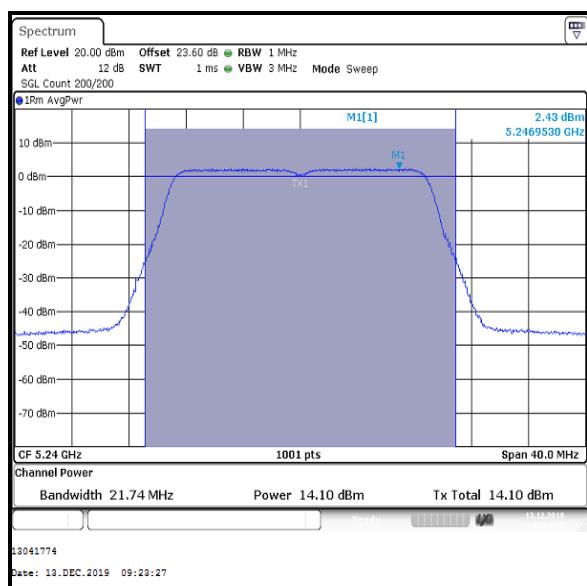
**Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5180	13.9	24.0	10.1	Complied
Middle	5200	13.9	24.0	10.1	Complied
Top	5240	14.1	24.0	9.9	Complied

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

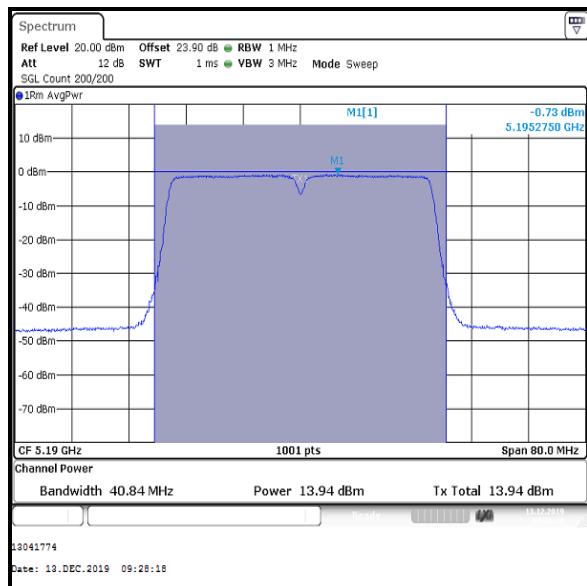
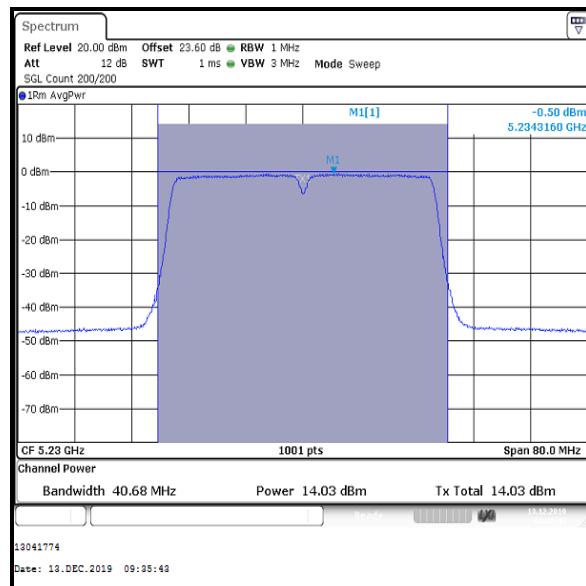
**Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5180	14.0	24.0	10.0	Complied
Middle	5200	14.2	24.0	9.8	Complied
Top	5240	14.1	24.0	9.9	Complied

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

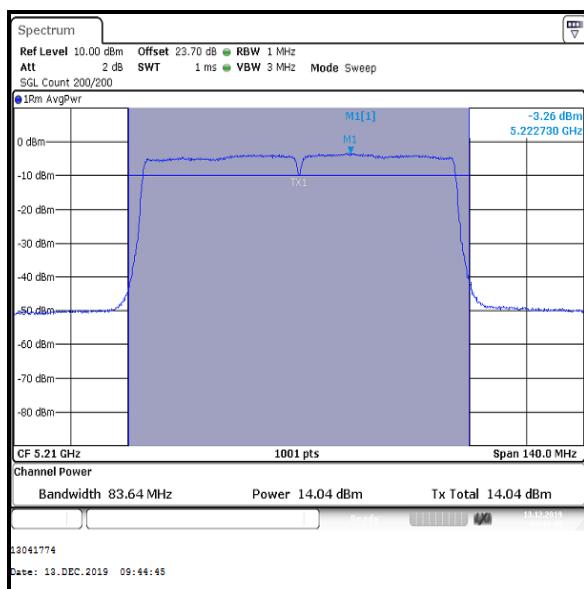
**Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5190	13.9	0.1	14.0	24.0	10.0	Complied
Top	5230	14.0	0.1	14.1	24.0	9.9	Complied

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

**Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5210	14.0	0.2	14.2	24.0	9.8	Complied

**Single Channel**

**Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band)****4.4.2. 5.25-5.35 GHz band****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	13 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(2)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	36

**Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band) (continued)****Note(s):**

1. Initial measurements were performed using a power meter to obtain the required power setting according to customer specified tolerances. This setting was then used to measure the power using the test methods listed below.
2. For conducted power tests where the duty cycle is >98%, the measurements were performed using a signal analyser in accordance with FCC KDB 789033 II.E.2.b) Method SA-1. Where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 789033 II.E.2.d) Method SA-2. The signal analyser's integration function was used to integrate across the 26 dB emission bandwidth. The resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time was set to auto and 200 traces performed. The span was set to encompass the entire 26 dB emission bandwidth. The channel power results are recorded in the tables below.
3. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
4. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured power in order to compute the average power during the actual transmission time.
5. The FCC Part 15.407(a)(2) limit is the lesser of 250 mW (24.0 dBm) or  $11 \text{ dBm} + 10 \log_{10} B$ , where B is the previously measured 26 dB emission bandwidth in MHz. For U-NII-2A band, the 26 dB EBW is greater than 20 MHz.

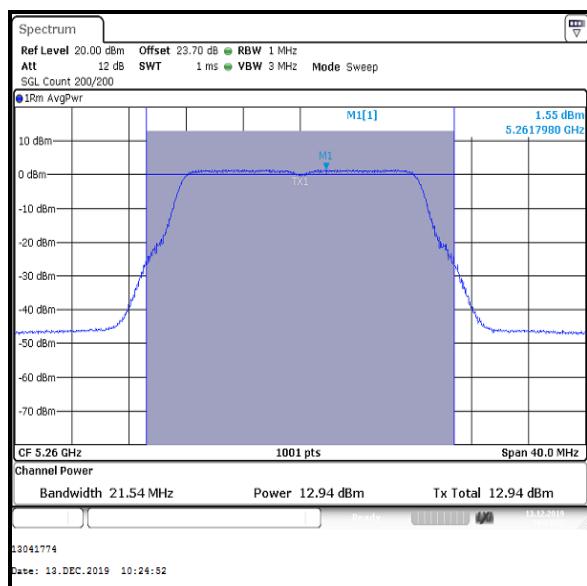
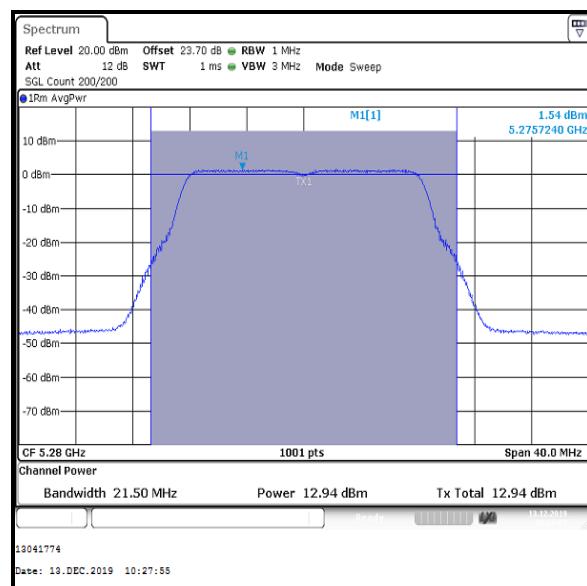
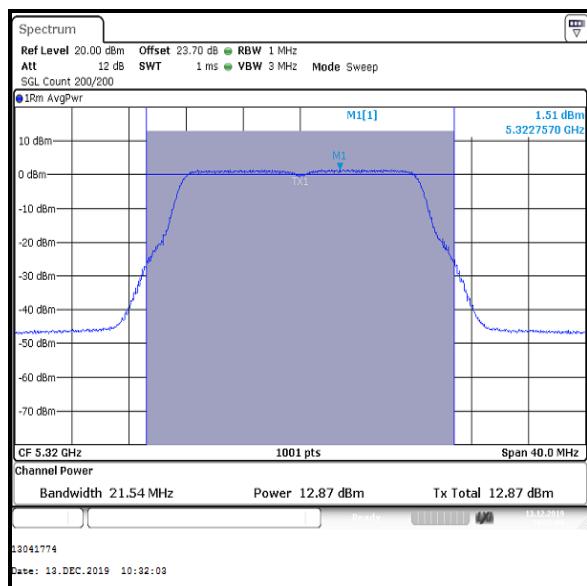
$$\begin{aligned} & \text{For } B > 20 \text{ MHz} \rightarrow \\ & \rightarrow \log_{10} B > \log_{10} 20 \rightarrow \\ & \rightarrow 10 \log_{10} B > 10 \log_{10} 20 \rightarrow \\ & \rightarrow 11 + 10 \log_{10} B > 11 + 10 \log_{10} 20 \rightarrow \\ & \rightarrow 11 + 10 \log_{10} B > 24.0 \text{ dBm} \end{aligned}$$

Therefore for measured emission bandwidths greater than 20 MHz, the lesser of the two limits is the fixed limit of 250 mW (24.0 dBm). This was applied to the results.

6. For all modes of operation, the antenna gain is < 6 dBi.
7. For details on antenna gains refer to Section 3.4 of this test report.
8. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

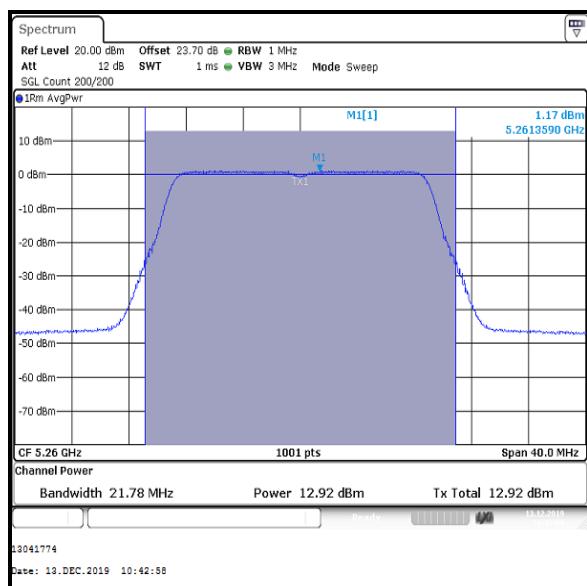
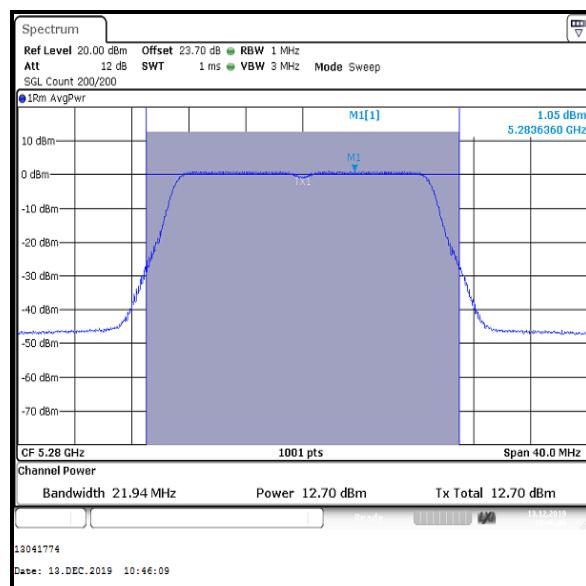
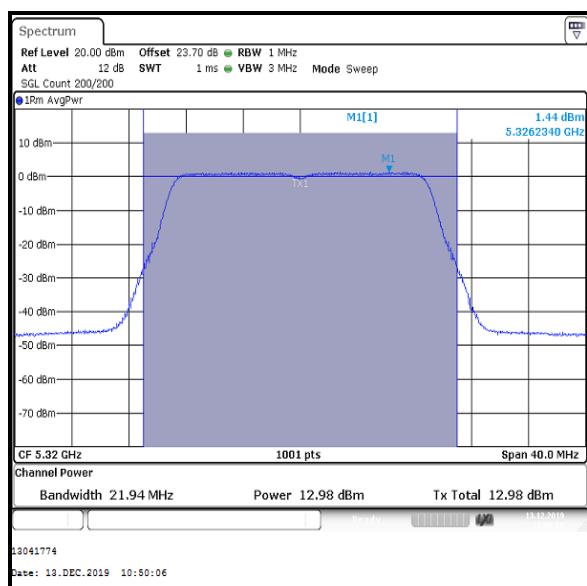
**Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5260	12.9	24.0	11.1	Complied
Middle	5280	12.9	24.0	11.1	Complied
Top	5320	12.9	24.0	11.1	Complied

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

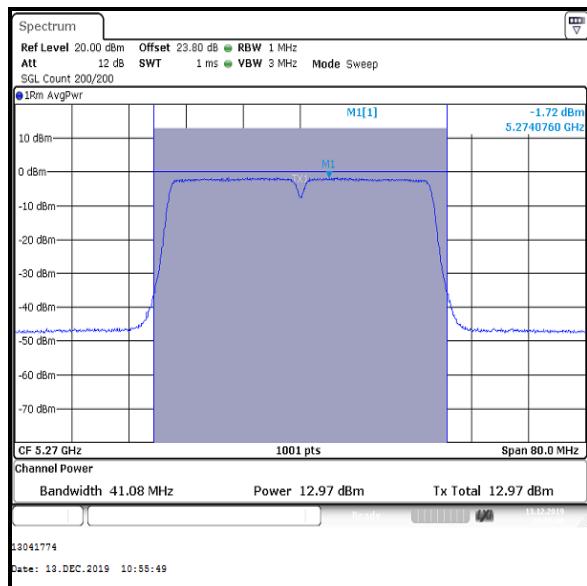
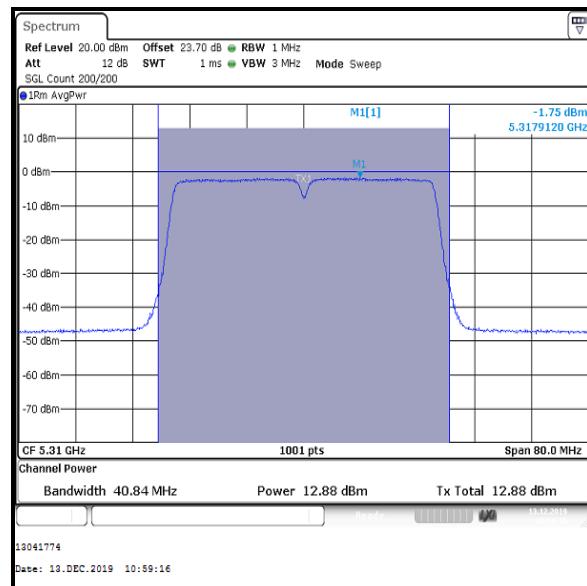
**Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5260	12.9	24.0	11.1	Complied
Middle	5280	12.7	24.0	11.3	Complied
Top	5320	13.0	24.0	11.0	Complied

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

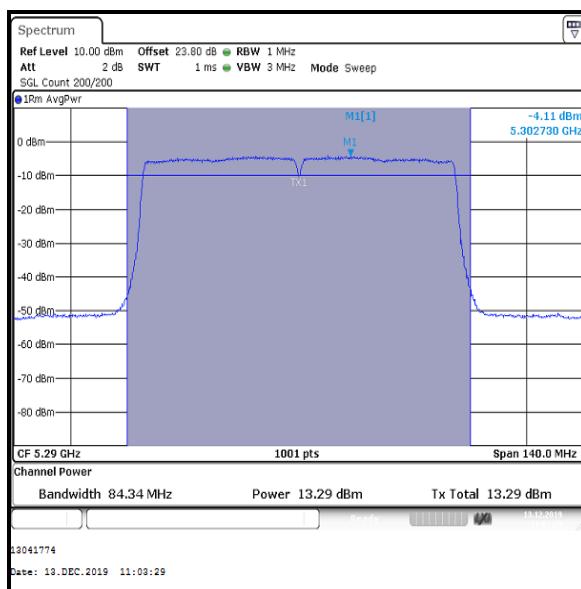
**Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5270	13.0	0.1	13.1	24.0	10.9	Complied
Top	5310	12.9	0.1	13.0	24.0	11.0	Complied

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

**Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5290	13.3	0.2	13.5	24.0	10.5	Complied

**Single Channel**

**Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band)****4.4.3. 5.47-5.725 GHz band****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Dates:</b>	13 December 2019 & 16 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(2)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	36 to 38

**Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band) (continued)****Note(s):**

1. Initial measurements were performed using a power meter to obtain the required power setting according to customer specified tolerances. This setting was then used to measure the power using the test methods listed below.
2. For conducted power tests where the duty cycle is >98%, the measurements were performed using a signal analyser in accordance with FCC KDB 789033 II.E.2.b) Method SA-1. Where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 789033 II.E.2.d) Method SA-2. The signal analyser's integration function was used to integrate across the 26 dB emission bandwidth. The resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time was set to auto and 200 traces performed. The span was set to encompass the entire 26 dB emission bandwidth. The channel power results are recorded in the tables below.
3. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
4. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured power in order to compute the average power during the actual transmission time.
5. The FCC Part 15.407(a)(2) limit is the lesser of 250 mW (24.0 dBm) or  $11 \text{ dBm} + 10 \log_{10} B$ , where B is the previously measured 26 dB emission bandwidth in MHz. For U-NII-2C band, the 26 dB EBW is greater than 20 MHz.

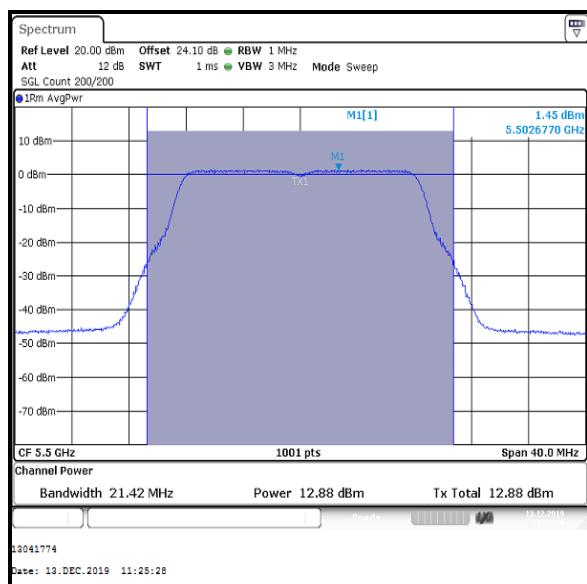
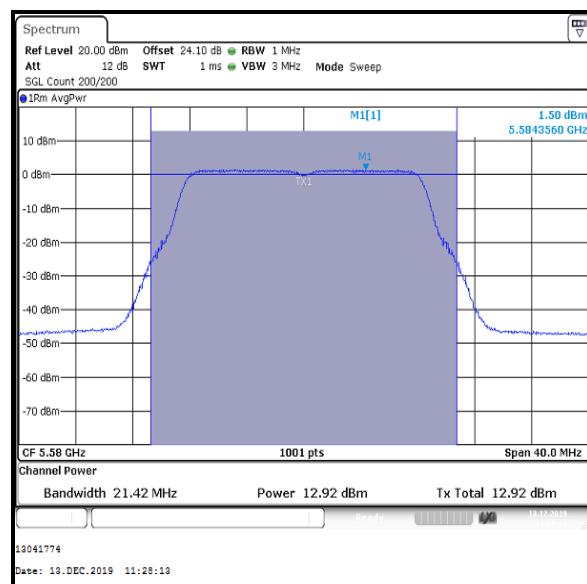
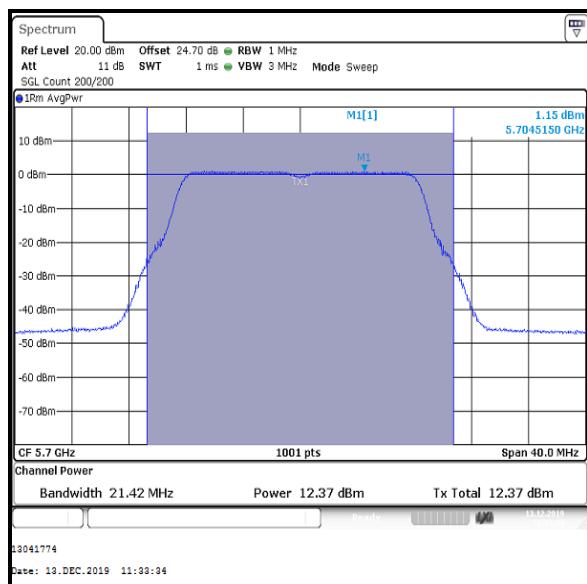
$$\begin{aligned} & \text{For } B > 20 \text{ MHz} \rightarrow \\ & \rightarrow \log_{10} B > \log_{10} 20 \rightarrow \\ & \rightarrow 10 \log_{10} B > 10 \log_{10} 20 \rightarrow \\ & \rightarrow 11 + 10 \log_{10} B > 11 + 10 \log_{10} 20 \rightarrow \\ & \rightarrow 11 + 10 \log_{10} B > 24.0 \text{ dBm} \end{aligned}$$

Therefore for measured emission bandwidths greater than 20 MHz, the lesser of the two limits is the fixed limit of 250 mW (24.0 dBm). This was applied to the results.

6. For all modes of operation, the antenna gain is < 6 dBi.
7. For details on antenna gains refer to Section 3.4 of this test report.
8. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

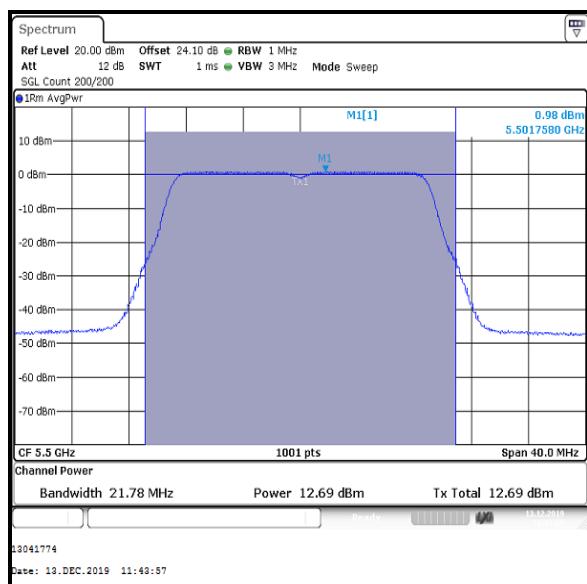
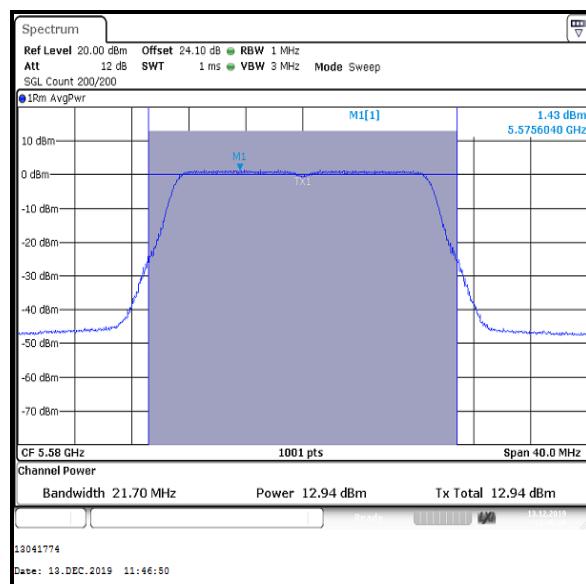
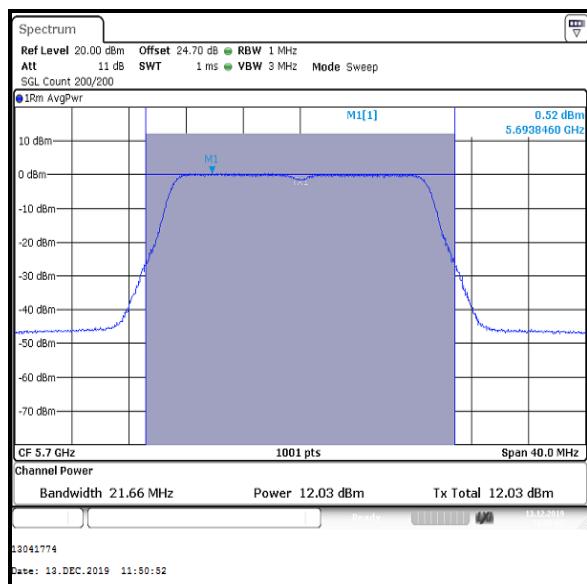
**Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5500	12.9	24.0	11.1	Complied
Middle	5580	12.9	24.0	11.1	Complied
Top	5700	12.4	24.0	11.6	Complied

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

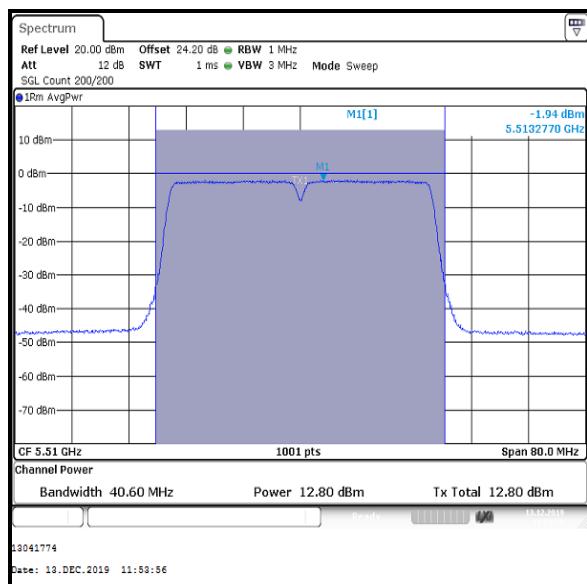
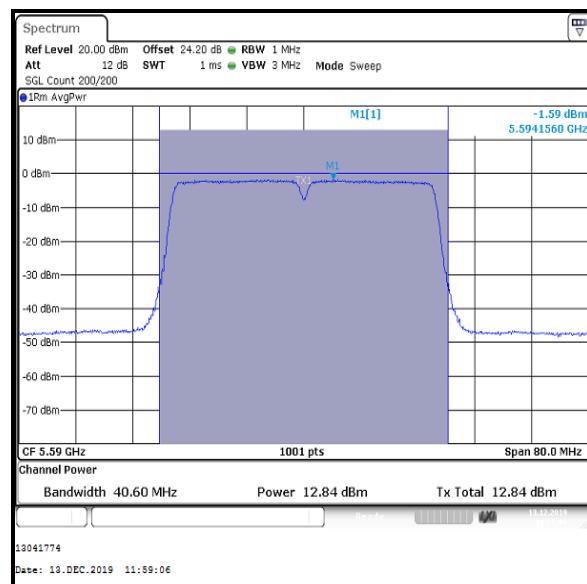
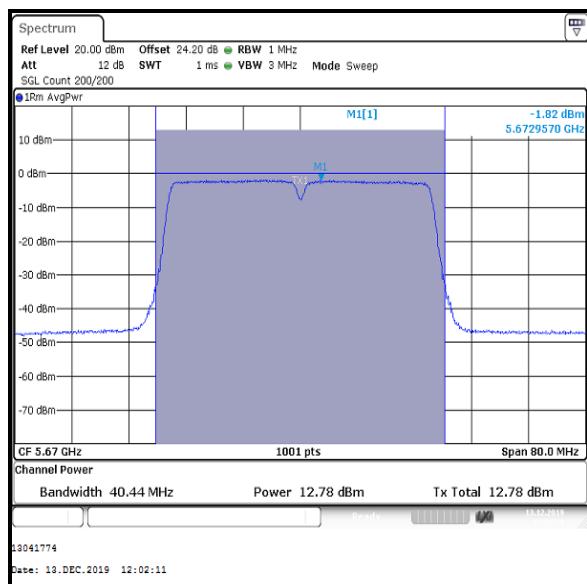
**Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band) (continued)****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5500	12.7	24.0	11.3	Complied
Middle	5580	12.9	24.0	11.1	Complied
Top	5700	12.0	24.0	12.0	Complied

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

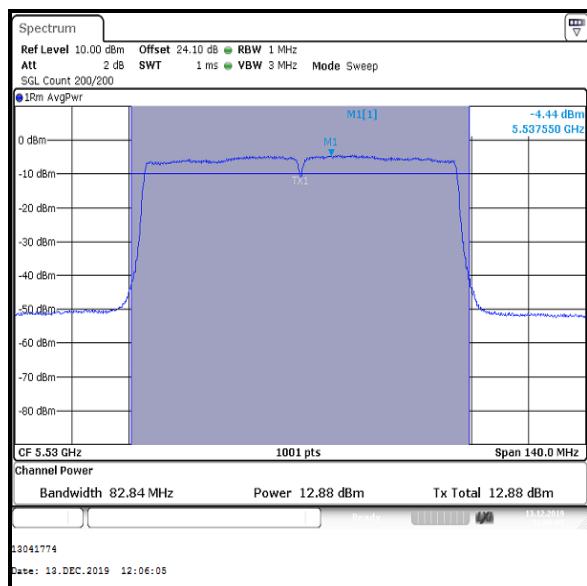
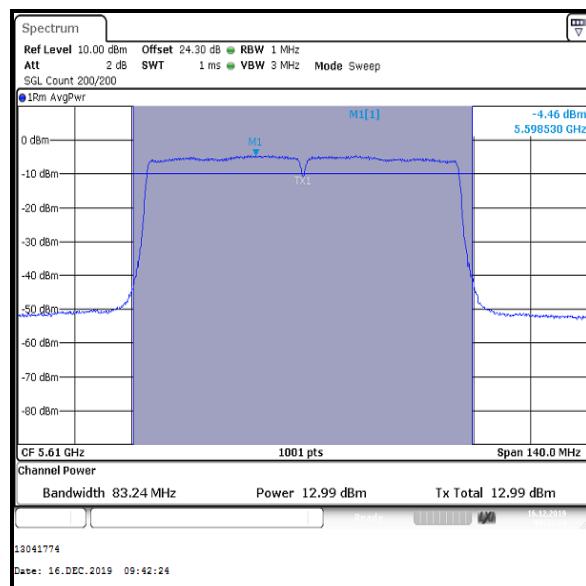
**Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5510	12.8	0.1	12.9	24.0	11.1	Complied
Middle	5590	12.8	0.1	12.9	24.0	11.1	Complied
Top	5670	12.8	0.1	12.9	24.0	11.1	Complied

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

**Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5530	12.9	0.2	13.1	24.0	10.9	Complied
Top	5610	13.0	0.2	13.2	24.0	10.8	Complied

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

**Transmitter Maximum Conducted Output Power (Straddle Channels)****4.4.4. Channels that straddle the U-NII-2C and U-NII-3 bands****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	13 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(2)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	36

**Transmitter Maximum Conducted Output Power (Straddle Channels) (continued)****Note(s):**

1. Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz need to meet requirements of both U-NII bands. Due to maximum conducted power limit being more stringent on U-NII-2C, compliance is shown against the limits of U-NII-2C. By default, the EUT also complies on U-NII-3.
2. Initial measurements were performed using a power meter to obtain the required power setting according to customer specified tolerances. This setting was then used to measure the power using the test methods listed below.
3. For conducted power tests where the duty cycle is >98%, the measurements were performed using a signal analyser in accordance with FCC KDB 789033 II.E.2.b) Method SA-1. Where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 789033 II.E.2.d) Method SA-2. The signal analyser's integration function was used to integrate across the 26 dB emission bandwidth. The resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time was set to auto and 200 traces performed. The span was set to encompass the entire 26 dB emission bandwidth. The channel power results are recorded in the tables below.
4. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
5. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured power in order to compute the average power during the actual transmission time.
6. The FCC Part 15.407(a)(2) limit is the lesser of 250 mW (24.0 dBm) or  $11 \text{ dBm} + 10 \log_{10} B$ , where B is the previously measured 26 dB emission bandwidth in MHz.

$$\begin{aligned} & \text{For } B > 20 \text{ MHz} \rightarrow \\ & \rightarrow \log_{10} B > \log_{10} 20 \rightarrow \\ & \rightarrow 10 \log_{10} B > 10 \log_{10} 20 \rightarrow \\ & \rightarrow 11 + 10 \log_{10} B > 11 + 10 \log_{10} 20 \rightarrow \\ & \rightarrow 11 + 10 \log_{10} B > 24.0 \text{ dBm} \end{aligned}$$

Therefore for measured emission bandwidths greater than 20 MHz, the lesser of the two limits is the fixed limit of 250 mW (24.0 dBm). This was applied to the relevant results.

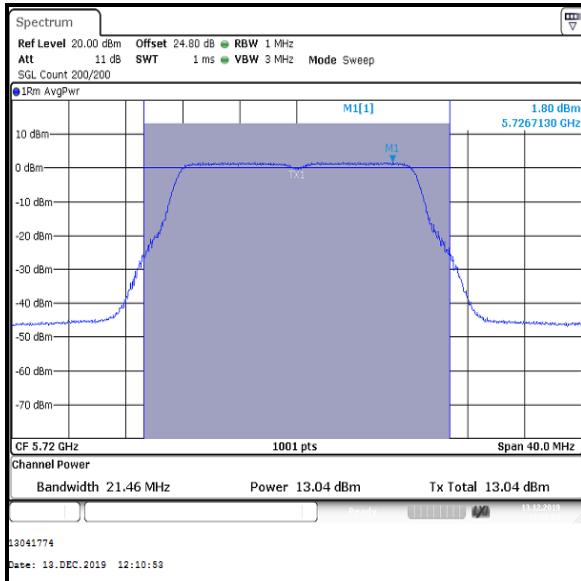
For measured emission bandwidths of less than 20 MHz, the limit for each channel was calculated as below:

$$\begin{aligned} 802.11a / \text{Single channel} &= 11 \text{ dBm} + 10 \log_{10} 15.749 = 23.0 \text{ dBm} \\ 802.11n \text{ HT20} / \text{Single channel} &= 11 \text{ dBm} + 10 \log_{10} 15.949 = 23.0 \text{ dBm} \end{aligned}$$

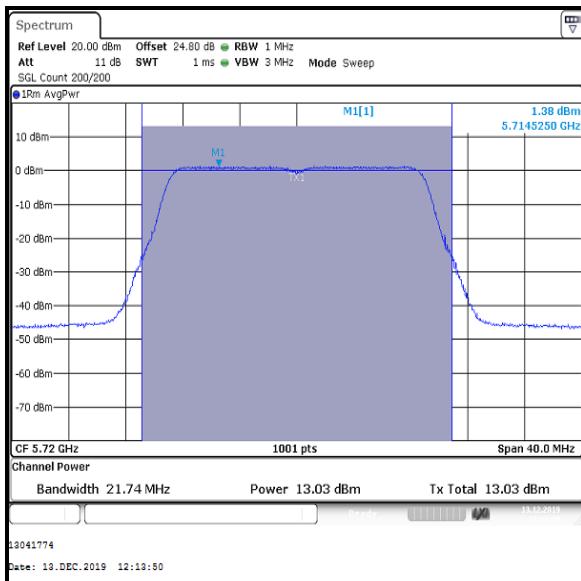
7. For all modes of operation, the antenna gain is < 6 dBi.
8. For details on antenna gains refer to Section 3.4 of this test report.
9. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

**Transmitter Maximum Conducted Output Power (Straddle Channels) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5720	13.0	23.0	10.0	Complied

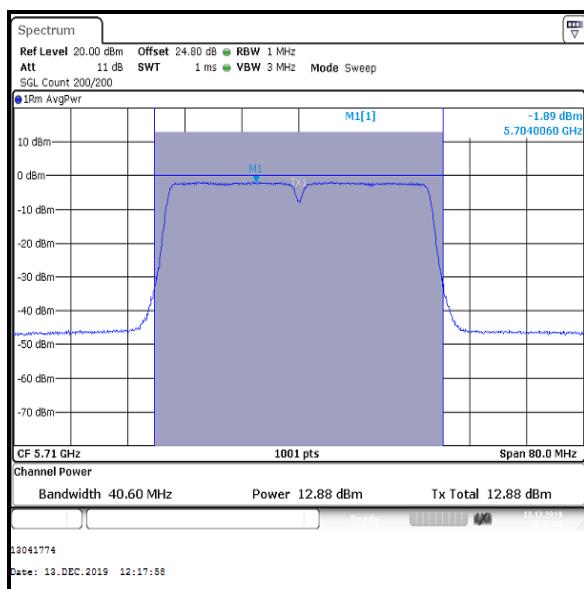
**Single Channel****Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5720	13.0	23.0	10.0	Complied

**Single Channel**

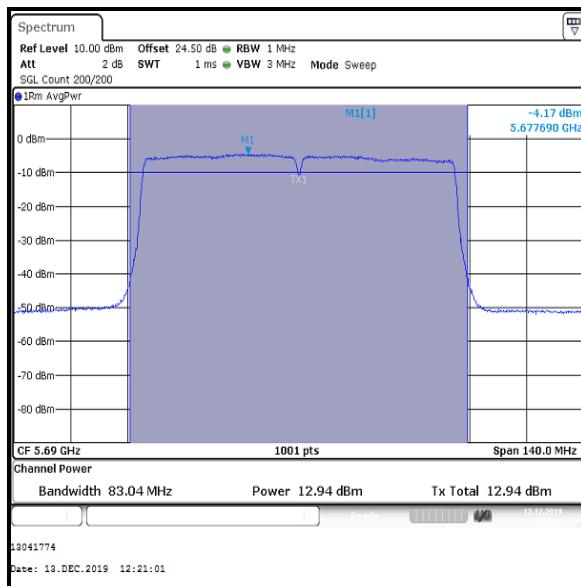
**Transmitter Maximum Conducted Output Power (Straddle Channels) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5710	12.9	0.1	13.0	24.0	11.0	Complied

**Single Channel**

**Transmitter Maximum Conducted Output Power (Straddle Channels) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5690	12.9	0.2	13.1	24.0	10.9	Complied

**Single Channel**

**Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band)****4.4.5. 5.725-5.85 GHz band****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	16 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(3)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	38

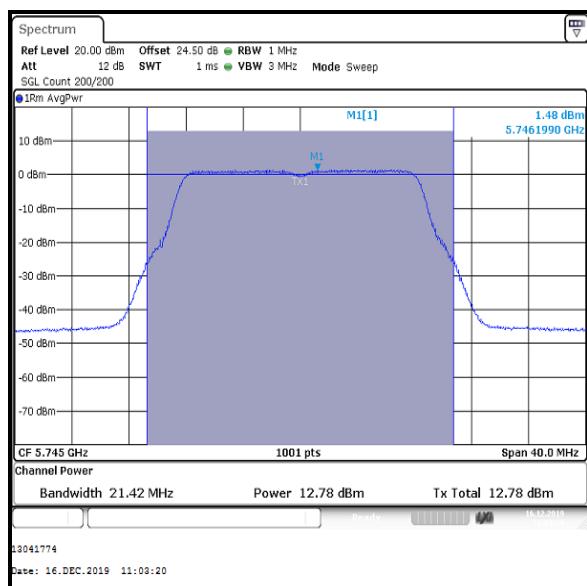
**Note(s):**

1. Initial measurements were performed using a power meter to obtain the required power setting according to customer specified tolerances. This setting was then used to measure the power using the test methods listed below.
2. For conducted power tests where the duty cycle is >98%, the measurements were performed using a signal analyser in accordance with FCC KDB 789033 II.E.2.b) Method SA-1. Where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 789033 II.E.2.d) Method SA-2. The signal analyser's integration function was used to integrate across the 26 dB emission bandwidth. The resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time was set to auto and 200 traces performed. The span was set to encompass the entire 26 dB emission bandwidth. The channel power results are recorded in the tables below.
3. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
4. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured power in order to compute the average power during the actual transmission time.
5. The FCC Part 15.407(a)(3) limit shall not exceed 1 W (30.0 dBm).
6. For all modes of operation, the antenna gain is < 6 dBi.
7. For details on antenna gains refer to Section 3.4 of this test report.
8. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

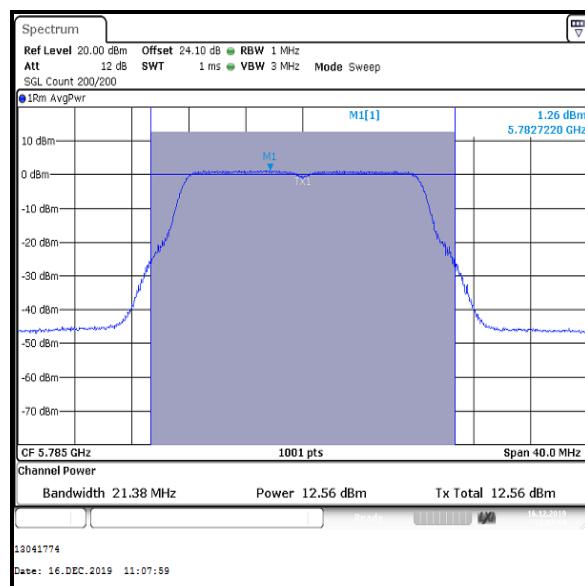
**Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band) (continued)**

## Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2

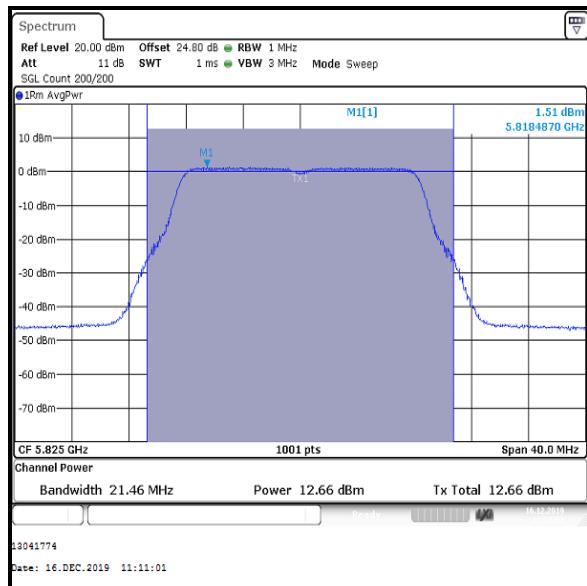
Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5745	12.8	30.0	17.2	Complied
Middle	5785	12.6	30.0	17.4	Complied
Top	5825	12.7	30.0	17.3	Complied



## Bottom Channel



## Middle Channel

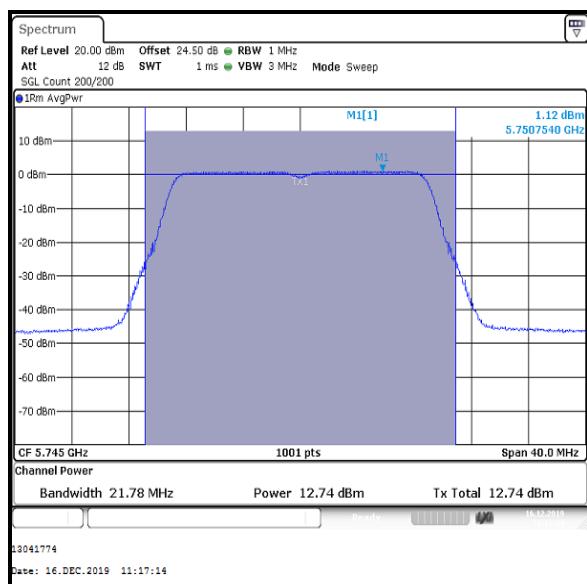


## Top Channel

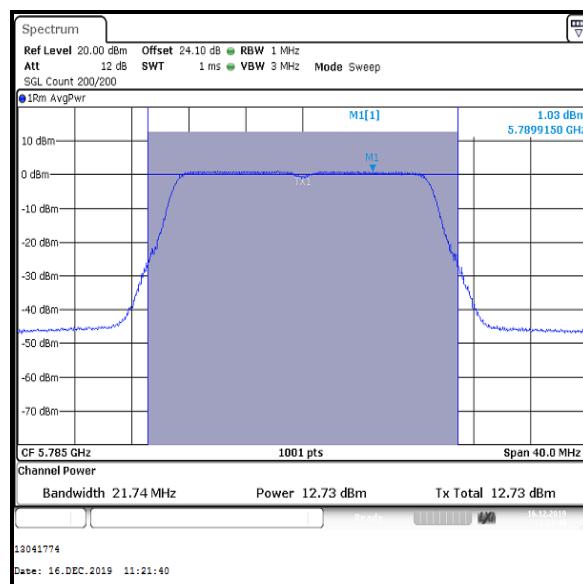
**Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band) (continued)**

## Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2

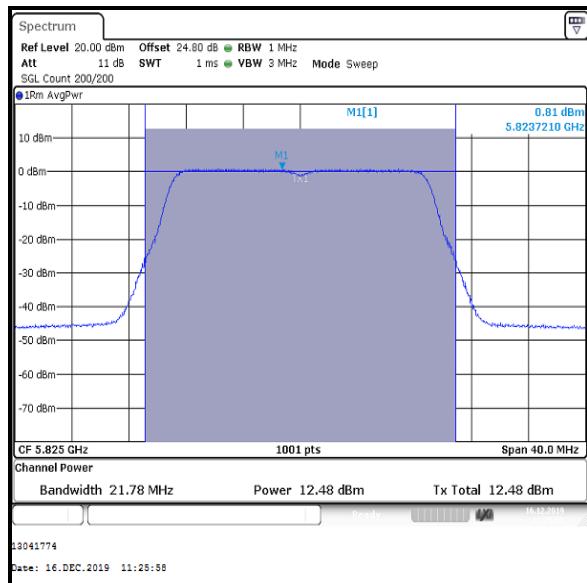
Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5745	12.7	30.0	17.3	Complied
Middle	5785	12.7	30.0	17.3	Complied
Top	5825	12.5	30.0	17.5	Complied



## Bottom Channel



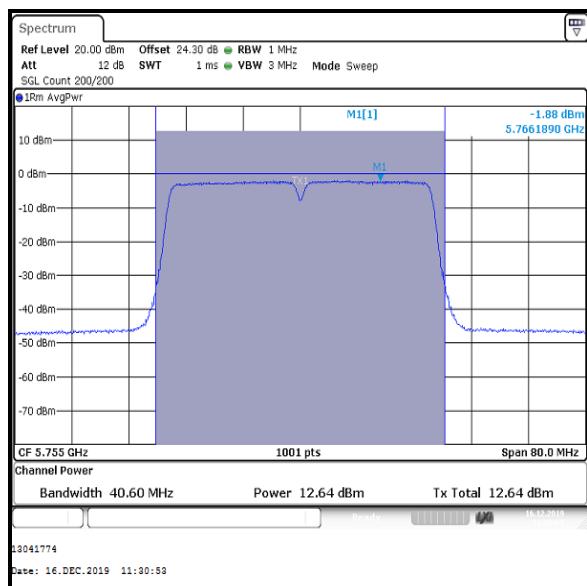
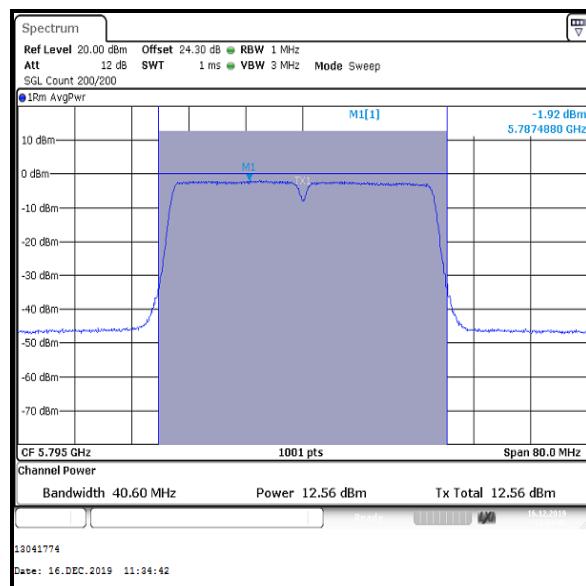
## Middle Channel



## Top Channel

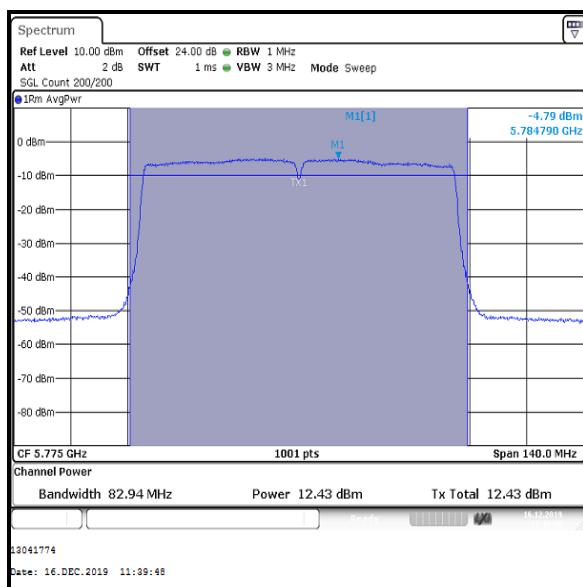
**Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band) (continued)****Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5755	12.6	0.1	12.7	30.0	17.3	Complied
Top	5795	12.6	0.1	12.7	30.0	17.3	Complied

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

**Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band) (continued)****Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5775	12.4	0.2	12.6	30.0	17.4	Complied

**Single Channel**

## **4.5. Transmitter Maximum Power Spectral Density**

### **4.5.1. 5.15-5.25 GHz band**

#### **Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	13 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(1)(iv)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.F. referencing II.E.2.b) and II.E.2.d)

#### **Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	36

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

1. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
2. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
3. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
4. FCC Part 15.407(a)(1)(iv) limit for PSD is <11 dBm/MHz.
5. For all modes of operation, the antenna gain is < 6 dBi.
6. For details on antenna gains refer to Section 3.4 of this test report.
7. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.
8. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power section 4.4 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.

**Transmitter Maximum Power Spectral Density (5.15-5.25 GHz band) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5180	2.5	11.0	8.5	Complied
Middle	5200	2.5	11.0	8.5	Complied
Top	5240	2.7	11.0	8.3	Complied

**Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5180	2.5	11.0	8.5	Complied
Middle	5200	2.5	11.0	8.5	Complied
Top	5240	2.4	11.0	8.6	Complied

**Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5190	-0.7	0.1	-0.6	11.0	11.6	Complied
Top	5230	-0.5	0.1	-0.4	11.0	11.4	Complied

**Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Single	5210	-3.3	0.2	-3.1	11.0	14.1	Complied

**Transmitter Maximum Power Spectral Density (5.25-5.35 GHz band)****4.5.2. 5.25-5.35 GHz band****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	13 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(2)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.F. referencing II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	36

**Note(s):**

1. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
2. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
3. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
4. FCC Part 15.407(a)(2) limit for PSD in the 5.25-5.35 GHz band is <11 dBm/MHz.
5. For all modes of operation, the antenna gain is < 6 dBi.
6. For details on antenna gains refer to Section 3.4 of this test report.
7. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.
8. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power section 4.4 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.

**Transmitter Maximum Power Spectral Density (5.25-5.35 GHz band) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5260	1.6	11.0	9.4	Complied
Middle	5280	1.5	11.0	9.5	Complied
Top	5320	1.5	11.0	9.5	Complied

**Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5260	1.2	11.0	9.8	Complied
Middle	5280	1.1	11.0	9.9	Complied
Top	5320	1.4	11.0	9.6	Complied

**Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5270	-1.7	0.1	-1.6	11.0	12.6	Complied
Top	5310	-1.8	0.1	-1.7	11.0	12.7	Complied

**Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Single	5290	-4.1	0.2	-3.9	11.0	14.9	Complied

**Transmitter Maximum Power Spectral Density (5.47-5.725 GHz band)****4.5.3. 5.47-5.725 GHz band****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Dates:</b>	13 December 2019 & 16 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(2)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.F. referencing II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	23 to 24
<b>Relative Humidity (%):</b>	36 to 38

**Note(s):**

1. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
2. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
3. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
4. FCC Part 15.407(a)(2) limit for PSD in the 5.47-5.725 GHz band is <11 dBm/MHz.
5. For all modes of operation, the antenna gain is < 6 dBi.
6. For details on antenna gains refer to Section 3.4 of this test report.
7. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.
8. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power section 4.4 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.

**Transmitter Maximum Power Spectral Density (5.47-5.725 GHz band) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Bottom	5500	1.5	11.0	9.5	Complied
Middle	5580	1.5	11.0	9.5	Complied
Top	5700	1.2	11.0	9.8	Complied

**Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Bottom	5500	1.0	11.0	10.0	Complied
Middle	5580	1.4	11.0	9.6	Complied
Top	5700	0.5	11.0	10.5	Complied

**Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Bottom	5510	-1.9	0.1	-1.8	11.0	12.8	Complied
Middle	5590	-1.6	0.1	-1.5	11.0	12.5	Complied
Top	5670	-1.8	0.1	-1.7	11.0	12.7	Complied

**Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Bottom	5530	-4.4	0.2	-4.2	11.0	15.2	Complied
Top	5610	-4.5	0.2	-4.3	11.0	15.3	Complied

**Transmitter Maximum Power Spectral Density (Straddle channels)****4.5.4. Channels that straddle the U-NII-2C and U-NII-3 bands****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	13 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(2)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.F. referencing II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	36

**Note(s):**

1. Channels that straddle the U-NII-2C and U-NII-3 bands at 5725 MHz, need to meet requirements of both U-NII bands. Due to maximum power spectral density limit being more stringent on U-NII-2C, compliance is shown against the limits of U-NII-2C. By default the EUT also complied on U-NII-3.
2. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
3. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
4. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
5. FCC Part 15.407(a)(2) limit for PPSD in the 5.47-5.725 GHz band is <11 dBm/MHz.
6. For all modes of operation, the antenna gain is < 6 dBi.
7. For details on antenna gains refer to Section 3.4 of this test report.
8. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.
9. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power section 4.4 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.

**Transmitter Maximum Power Spectral Density (Straddle channels) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Single	5720	1.8	11.0	9.2	Complied

**Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Single	5720	1.4	11.0	9.6	Complied

**Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Single	5710	-1.9	0.1	-1.8	11.0	12.8	Complied

**Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm/MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)	Result
Single	5690	-4.2	0.2	-4.0	11.0	15.0	Complied

**Transmitter Maximum Power Spectral Density (5.725-5.85 GHz band)****4.5.5. 5.725-5.85 GHz band****Test Summary:**

<b>Test Engineers:</b>	Max Passell & Patrick Jones	<b>Test Date:</b>	16 December 2019
<b>Test Sample Serial Number:</b>	C02ZH007P1YX		

<b>FCC Reference:</b>	Part 15.407(a)(3)
<b>Test Method Used:</b>	KDB 789033 D02 Section II.F. referencing II.E.2.b) and II.E.2.d)

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	38

**Note(s):**

1. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
2. Measurements were performed using configurations detailed in Section 3.5 of this test report on the relevant channels.
3. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 4.1 was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
4. FCC Part 15.407(a)(3) limit for PPSD in the 5.725-5.85 GHz operating band is <30 dBm/500 kHz.
5. In accordance with ANSI C63.10 Section 4.1.4.1, use of bandwidths greater than those specified can produce higher readings. Compliance against the applicable limits is shown using a 1 MHz resolution bandwidth. This was deemed worst case.
6. For all modes of operation, the antenna gain is < 6 dBi.
7. For details on antenna gains refer to Section 3.4 of this test report.
8. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.
9. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power section 4.4 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.

**Transmitter Maximum Power Spectral Density (5.725-5.85 GHz band) (continued)****Results: 802.11a / 20 MHz / SISO / BPSK / 6 Mbps / Core 2**

Channel	Frequency (MHz)	PSD (dBm / 1 MHz)	Limit (dBm / 500 kHz)	Margin (dB)	Result
Bottom	5745	1.5	30.0	28.5	Complied
Middle	5785	1.3	30.0	28.7	Complied
Top	5825	1.5	30.0	28.5	Complied

**Results: 802.11n / 20 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm / 1 MHz)	Limit (dBm / 500 kHz)	Margin (dB)	Result
Bottom	5745	1.1	30.0	28.9	Complied
Middle	5785	1.0	30.0	29.0	Complied
Top	5825	0.8	30.0	29.2	Complied

**Results: 802.11n / 40 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm / 1 MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm / 1 MHz)	Limit (dBm / 500 kHz)	Margin (dB)	Result
Bottom	5755	-1.9	0.1	-1.8	30.0	31.8	Complied
Top	5795	-1.9	0.1	-1.8	30.0	31.8	Complied

**Results: 802.11ac / 80 MHz / SISO / BPSK / MCS0 / Core 2**

Channel	Frequency (MHz)	PSD (dBm / 1 MHz)	Duty cycle correction factor (dB)	Corrected PSD (dBm / 1 MHz)	Limit (dBm / 500 kHz)	Margin (dB)	Result
Single	5775	-4.8	0.2	-4.6	30.0	34.6	Complied

## **5. Radiated Test Results**

### **5.1. Transmitter Out of Band Radiated Emissions <1 GHz**

#### **Test Summary:**

<b>Test Engineer:</b>	Andrew Harding	<b>Test Date:</b>	09 January 2020
<b>Test Sample Serial Number:</b>	C02ZG00KP22J		

<b>FCC Reference:</b>	Parts 15.407(b)(1),(6),(7) & 15.209(a)
<b>Test Method Used:</b>	KDB 789033 II.G. & ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range:</b>	30 MHz to 1000 MHz

#### **Environmental Conditions:**

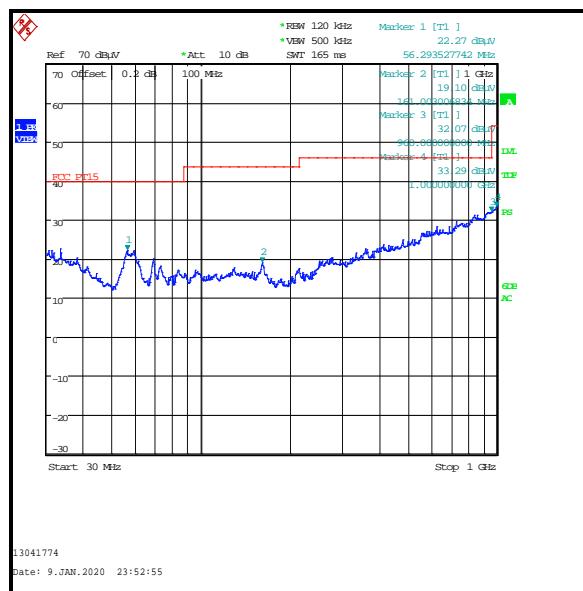
<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	35

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

1. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
2. Pre-scans were performed with the EUT transmitting in the band 5.15 to 5.25 GHz band with a configuration of 802.11n / HT20 / MCS0 on middle channel in this band as it produced the highest output power and was therefore deemed worst case. An inquiry was made to the FCC and the response was pre-scans could be performed in the band with the highest output power and all final measurements should be performed on any emissions seen in each band.
3. All emissions shown on the pre-scan plots were investigated and found to be ambient, or >20 dB below the applicable limit or below the measurement system noise floor. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
4. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. The sweep time was set to auto. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: Peak / Middle Channel / 802.11n / HT20 / MCS0**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1000.000	Vertical	33.3	54.0	20.7	Complied



## **5.2. Transmitter Out of Band Radiated Emissions >1 GHz**

### **5.2.1. 5.15-5.25 GHz band**

#### **Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation)**

##### **Test Summary:**

<b>Test Engineers:</b>	John Ferdinand, Andrew Harding & Mohamed Toubella	<b>Test Dates:</b>	06 December 2019, 18 December 2019 & 10 January 2020
<b>Test Sample Serial Numbers:</b>	C02ZG00KP22J & C02ZG00UP22J		

<b>FCC Reference:</b>	Part 15.407(b)(1),(7) & 15.209(a)
<b>Test Method Used:</b>	KDB 789033 II.G. & ANSI C63.10 Sections 6.3 and 6.6
<b>Frequency Range:</b>	1 GHz to 40 GHz

##### **Environmental Conditions:**

<b>Temperature (°C):</b>	23
<b>Relative Humidity (%):</b>	35 to 41

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Note(s):**

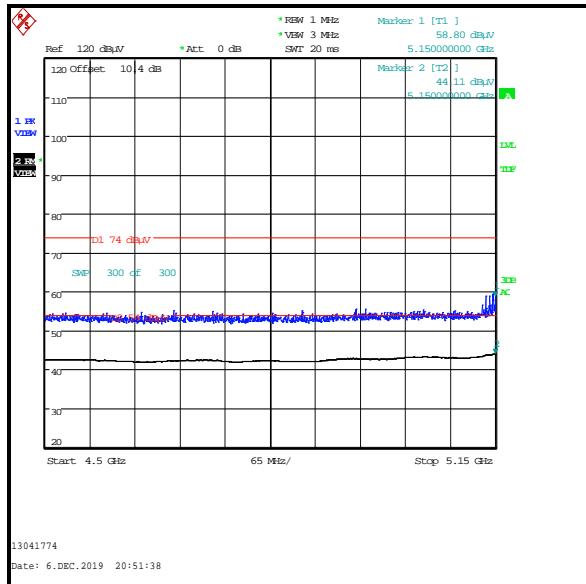
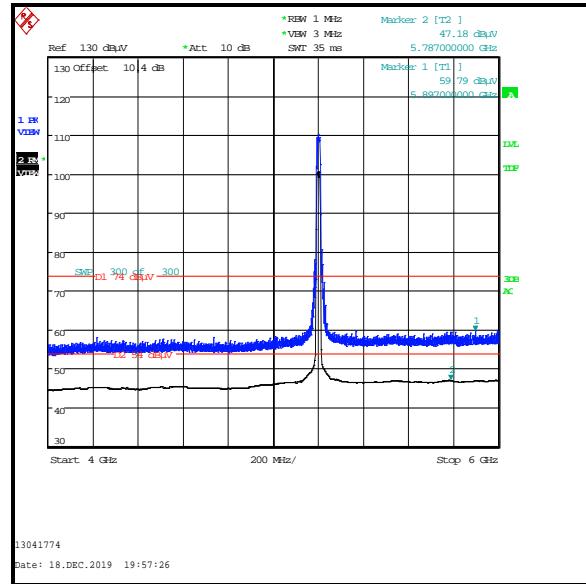
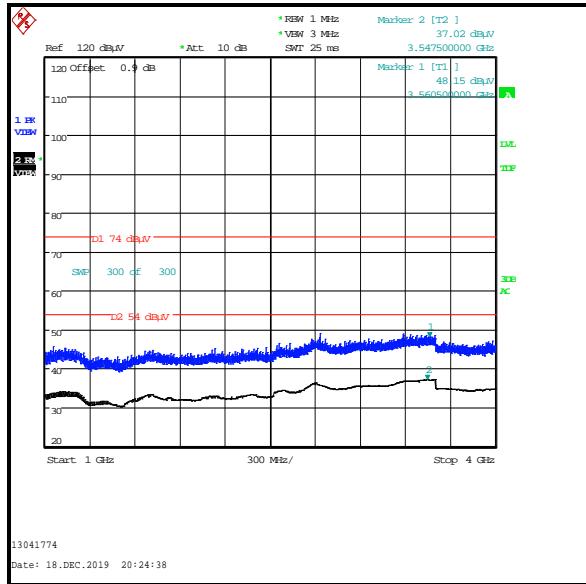
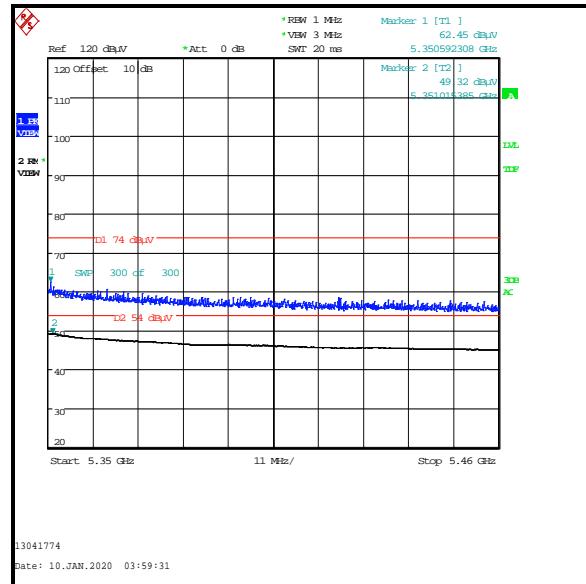
1. FCC Part 15.407(b)(1) states for transmitters operating in the band 5.15 to 5.25 GHz: all emissions outside of the 5.15 to 5.35 GHz band will not exceed -27 dBm/MHz. Part(b)(7) states the provisions of 15.205 apply e.g. restricted bands of operation.
2. Pre-scans were performed with the EUT transmitting on the middle channel in this band. An inquiry was made to the FCC and the response was pre-scans could be performed in the band with the highest output power and all final measurements should be performed on any emissions seen in each band.
3. In accordance with ANSI section 5.6.2.2, radiated emissions measurements were performed on the mode which had the highest power (802.11n / HT20 / MCS0) and the mode with the highest PSD (802.11a / 6 Mbps). Pre-scans were performed on both modes. Plots in the report are for 802.11n HT20 and the pre-scans for 802.11a are stored on the company IT server and are available upon request.
4. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
5. The emission shown on the 4 GHz to 6 GHz plot is the EUT fundamental.
6. All emissions shown on the pre-scan plots were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor. Therefore the highest peak and average noise floor readings of the measuring receiver were recorded.
7. Appropriate RF filters and attenuators were used during pre-scans and final measurements. Insertion losses were entered on the spectrum analyser as RF levels offsets.
8. Measurements were performed across the two restricted bands closest to the bands of operation with the EUT transmitting on the bottom channel in the 5.15 to 5.25 GHz band and top channel in the 5.25 to 5.35 GHz band. Plots are included in this section of the test report. Peak and average measurements were made.
9. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0001 or K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

**Results: Middle Channel / Field Strength / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
5350.592	Vertical	62.5	74.0	11.5	Complied

**Results: Middle Channel / Field Strength / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
5351.015	Vertical	49.3	54.0	4.7	Complied

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Restricted Band 4.5 GHz to 5.15 GHz****Restricted Band 5.35 GHz to 5.46 GHz**