

Appendix C: Test result for 5.725GHz – 5.850GHz.

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TEST CONDITIONS

Power supply (V):

Vnominal = 12.6 Vdc

Type of power supply = External power supply (Battery).

Type of antenna: External antenna.

Declared Gain for antenna (maximum) at each Antenna:

$G_{Ant1,2} = +3.2 \text{ dBi}$

$G_{Ant3} = +0.9 \text{ dBi}$

$G_{Ant4} = +2.3 \text{ dBi}$

Technology Tested:	WLAN (IEEE 802.11 a,n,ac) / U-NII	
Modes:	802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO)	
	802.11n HT20: MCS0 to MCS23 (SISO or 2 chain MIMO)	
	802.11n HT40: MCS0 to MCS23 (SISO or 2 chain MIMO)	
	802.11ac VHT80: MCS0 to MCS9 (SISO, or 2 chain MIMO)	
Setting of cores / ports:	1,2,3,4 and 1+4	
Beamforming:	No	
Frequency Range:	5725 MHz to 5850 MHz	
Channel Spacing:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Lowest: 149	5745
	Middle: 157	5785
	Highest: 165	5825
Channel Spacing:	40 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Lowest: 151	5755
	Highest: 159	5795
Channel Spacing:	80 MHz	
Transmit Channels	Middle: 155	5775

The test set-up was made in accordance to the general provisions of ANSI C63.10: 2013 and FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01 dated 12/14/2017 and FCC KDB 662911 D01 Multiple Transmitter Output v02r01 dated 10/31/2013.

The EUT was tested in the following operating mode:

- Continuously transmitting with a modulated carrier at maximum power in all required channels using the supported data rates/modulations types.

The field strength at the band edges was evaluated for each mode individually on the lowest and highest channels at the rated power for the channel under test.

For all modes, the EUT was configured in test mode using a software application. The application was used to enable a continuous transmission and to select the test channels as required. The client supplied scripts to configure the EUT. The customer supplied a document containing the setup instructions.

The worst cases for testing were identified for output power and spurious levels at the band edges which were selected based on preliminary testing that correspond to next data rates:

- 802.11a: 6 Mbits / SISO
- 802.11n HT20: MCS0 / SISO
- 802.11n HT40: MCS0 / SISO
- 802.11ac VHT80: MCS0 / SISO
- 802.11n HT20: MCS0 / MIMO
- 802.11n HT40: MCS0 / MIMO
- 802.11ac VHT80: MCS0 / MIMO

It was necessary to change between WLAN 1-CORE 0 with antenna 3, WLAN0-CORE 0 with antenna 1 or 2, WLAN1-CORE 1 with antenna 4 and WLAN 0-CORE 2 (CORE 0+CORE 1) with antenna 1 and 4 (MiMo Configuration).

WIFI FCC:

```
tx_test.sh -a wlan0 stop
```

Wlan0

a20 - Core0

```
tx_test.sh -a wlan0 149 0 -d x -r 6 20 -c US
```

```
tx_test.sh -a wlan0 157 0 -d x -r 6 20 -c US
```

```
tx_test.sh -a wlan0 165 0 -d x -r 6 20 -c US
```

n20 - Core0

```
tx_test.sh -a wlan0 149 0 -d x -h 0 20 -c US
```

```
tx_test.sh -a wlan0 157 0 -d x -h 0 20 -c US
```

```
tx_test.sh -a wlan0 165 0 -d x -h 0 20 -c US
```

n40 - Core0

```
tx_test.sh -a wlan0 153 0 -d x -h 0 40 -c US
```

```
tx_test.sh -a wlan0 161 0 -d x -h 0 40 -c US
```

ac80 - Core0

```
tx_test.sh -a wlan0 161 0 -d x -v 0 80 -c US
```

Wlan1

a20 - Core0

tx_test.sh -a wlan1 149 0 -d x -r 6 20 -c US

tx_test.sh -a wlan1 157 0 -d x -r 6 20 -c US

tx_test.sh -a wlan1 165 0 -d x -r 6 20 -c US

n20 - Core0

tx_test.sh -a wlan1 149 0 -d x -h 0 20 -c US

tx_test.sh -a wlan1 157 0 -d x -h 0 20 -c US

tx_test.sh -a wlan1 165 0 -d x -h 0 20 -c US

n40 - Core0

tx_test.sh -a wlan1 153 0 -d x -h 0 40 -c US

tx_test.sh -a wlan1 161 0 -d x -h 0 40 -c US

ac80 - Core0

tx_test.sh -a wlan1 161 0 -d x -v 0 80 -c US

a20 – Core1

tx_test.sh -a wlan1 149 1 -d x -r 6 20 -c US

tx_test.sh -a wlan1 157 1 -d x -r 6 20 -c US

tx_test.sh -a wlan1 165 1 -d x -r 6 20 -c US

n20 – Core1

tx_test.sh -a wlan1 149 1 -d x -h 0 20 -c US

tx_test.sh -a wlan1 157 1 -d x -h 0 20 -c US

tx_test.sh -a wlan1 165 1 -d x -h 0 20 -c US

n40 – Core1

tx_test.sh -a wlan1 153 1 -d x -h 0 40 -c US

tx_test.sh -a wlan1 161 1 -d x -h 0 40 -c US

ac80 – Core1

tx_test.sh -a wlan1 161 1 -d x -v 0 80 -c US

MIMO:

n20 – Core2

tx_test.sh -a wlan0 149 2 -d x -h 0 20 -c US

tx_test.sh -a wlan0 157 2 -d x -h 0 20 -c US

tx_test.sh -a wlan0 165 2 -d x -h 0 20 -c US

n40 – Core2

tx_test.sh -a wlan0 153 2 -d x -h 0 40 -c US

tx_test.sh -a wlan0 161 2 -d x -h 0 40 -c US

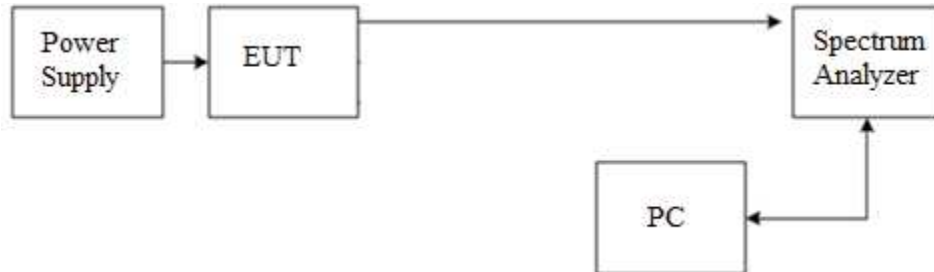
ac80 – Core2

tx_test.sh -a wlan0 161 2 -d x -v 0 80 -c US

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and connected to the spectrum analyzer using a low loss RF cable. The reading in the spectrum analyzer is corrected taking into account the internal and external RF cable loss.

For all modes:



The DC supply voltage is applied using an external power supply.

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 1 m for the frequency range 1 GHz-40 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

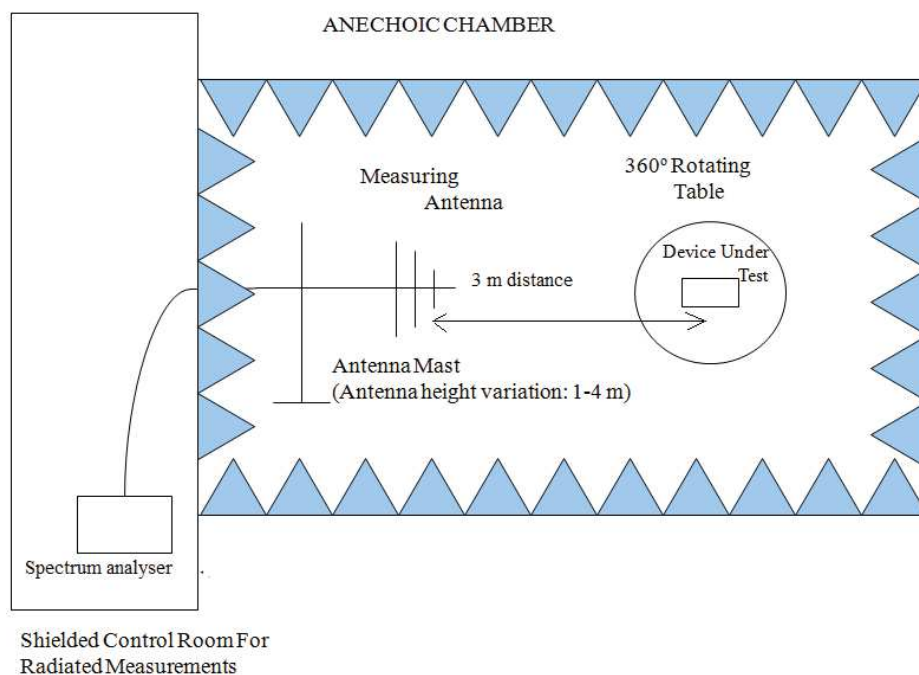
For radiated emissions in the range 1 GHz-40 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The EUT was placed at a height of 80 cm above the reference ground plane in the center of the chamber turntable to perform the measurements below 1GHz and the EUT was placed at a height of 1.5 meters above the test chamber floor in the center of the chamber turntable to perform the measurements above 1GHz. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

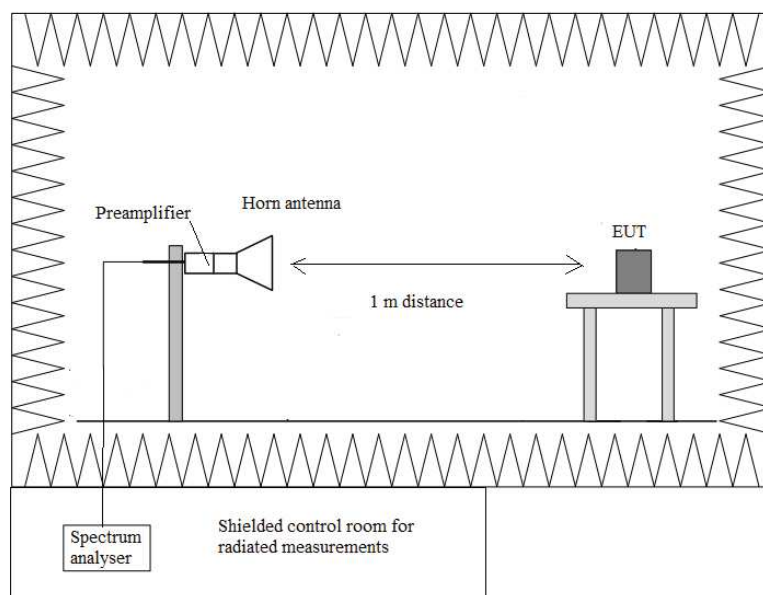
Measurements were made in both horizontal and vertical planes of polarization.

The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.

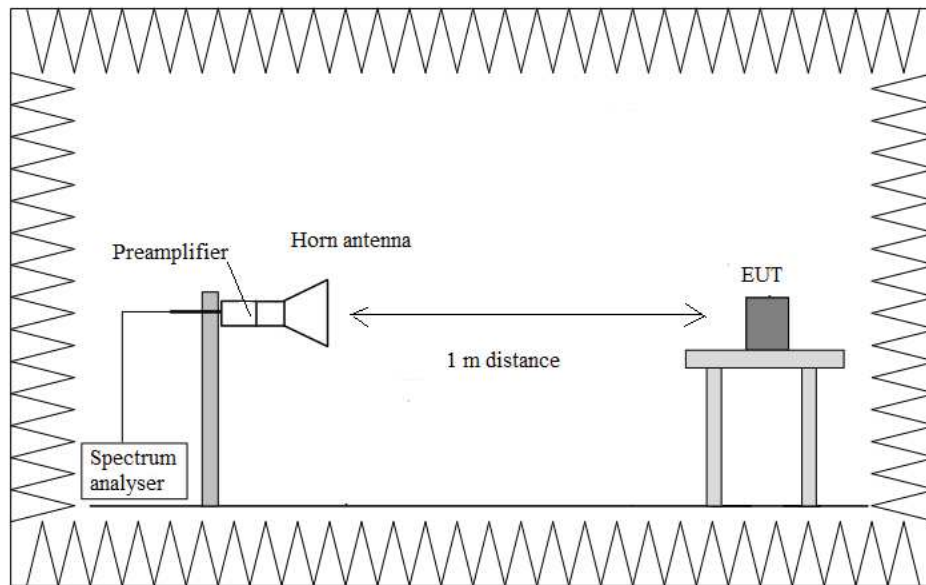
Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz up to 18 GHz.



Radiated measurements setup $f > 18$ GHz up to 40 GHz.



FCC Section 15.247 Subclause (e) / RSS-247 6.2.4.1. 6 dB Bandwidth

SPECIFICATION

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS:

6 dB Bandwidth (see next plots).

The following modes and data rates were selected based on preliminary testing that identified those corresponding to the worst cases:

Measurements were performed on the SISO modes for testing:

- 802.11a: 6 Mbit/s / SISO on WLAN0-Core 0 – Antenna RF Port 2
- 802.11n HT20: MCS0 / SISO on WLAN0-Core 0 – Antenna RF Port 2
- 802.11n HT40: MCS0 / SISO on WLAN0-Core 0 – Antenna RF Port 2
- 802.11ac VHT80: MCS0x1 / SISO on WLAN0-Core 0 – Antenna RF Port 2

- 802.11a: 6 Mbit/s / SISO on WLAN1-Core 0 – Antenna RF Port 3
- 802.11n HT20: MCS0 / SISO on WLAN1-Core 0 – Antenna RF Port 3
- 802.11n HT40: MCS0 / SISO on WLAN1-Core 0 – Antenna RF Port 3
- 802.11ac VHT80: MCS0x1 / SISO on WLAN1-Core 0 – Antenna RF Port 3

- 802.11a: 6 Mbit/s / SISO on WLAN1-Core 1 – Antenna RF Port 4
- 802.11n HT20: MCS0 / SISO on WLAN1-Core 1 – Antenna RF Port 4
- 802.11n HT40: MCS0 / SISO on WLAN1-Core 1 – Antenna RF Port 4
- 802.11ac VHT80: MCS0x1 / SISO on WLAN1-Core 1 – Antenna RF Port 4

Measurements were performed on the MIMO mode for testing:

- 802.11n HT20: MCS0 / MIMO on WLAN0 CORE2 (CORE0+CORE1) –Antenna Port 1 - 4
- 802.11n HT40: MCS0 / MIMO on WLAN0 CORE2 (CORE0+CORE1) –Antenna Port 1 - 4
- 802.11ac VHT80: MCS0 / MIMO on WLAN0 CORE2 (CORE0+CORE1) –Antenna Port 1 - 4

WLAN0 - CORE 0 – SISO - Antenna port 2

Mode : 802.11a - 20MHz

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	16.347	16.333	16.347
Measurement uncertainty (kHz)	<± 23.02		

Mode : 802.11n HT20 - 20MHz

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	17.573	17.600	17.573
Measurement uncertainty (kHz)	<± 23.02		

Mode : 802.11n HT40 - 40MHz

	Channel 151 5755 MHz	Channel 159 5795 MHz
6 dB bandwidth (MHz)	35.48	35.92
Measurement uncertainty (kHz)	<± 53.05	

Mode : 802.11ac VHT80 - 80MHz

	Channel 155 5775 MHz
6 dB bandwidth (MHz)	75.44
Measurement uncertainty (kHz)	<± 103.10

Verdict: PASS

WLAN1 - CORE 0 – SISO - Antenna port 3

Mode : 802.11a - 20MHz

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	16.347	16.333	16.333
Measurement uncertainty (kHz)	<± 23.02		

Mode : 802.11n HT20 - 20MHz:

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	17.573	17.547	17.560
Measurement uncertainty (kHz)	<± 23.02		

Mode : 802.11n HT40 - 40MHz

	Channel 151 5755 MHz	Channel 159 5795 MHz
6 dB bandwidth (MHz)	35.840	35.820
Measurement uncertainty (kHz)	<± 53.05	

Mode : 802.11ac VHT80 - 80MHz

	Channel 155 5775 MHz
6 dB bandwidth (MHz)	75.44
Measurement uncertainty (kHz)	<± 103.10

Verdict: PASS

WLAN1 - CORE 1 – SISO - Antenna port 4

Mode : 802.11a - 20MHz

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	16.347	16.320	16.333
Measurement uncertainty (kHz)	<± 23.02		

Mode : 802.11n HT20 - 20MHz:

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	17.573	17.547	17.587
Measurement uncertainty (kHz)	<± 23.02		

Mode : 802.11n HT40 - 40MHz

	Channel 151 5755 MHz	Channel 159 5795 MHz
6 dB bandwidth (MHz)	35.66	35.73
Measurement uncertainty (kHz)	<± 53.05	

Mode : 802.11ac VHT80 - 80MHz

	Channel 155 5775 MHz
6 dB bandwidth (MHz)	75.68
Measurement uncertainty (kHz)	<± 103.10

Verdict: PASS

WLAN1 CORE 2 (CORE0 + CORE1) - MIMO – Antenna ports 1 - 4

Mode : 802.11n HT20 - 20MHz:

Antenna 1:

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	17.573	17.587	17.587
Measurement uncertainty (kHz)	<± 23.02		

Antenna 4:

	Channel 149 5745 MHz	Channel 157 5785 MHz	Channel 165 5825 MHz
6 dB bandwidth (MHz)	17.600	17.600	17.613
Measurement uncertainty (kHz)	<± 23.02		

Mode : 802.11n HT40 - 40MHz

Antenna 1:

	Channel 151 5755 MHz	Channel 159 5795 MHz
6 dB bandwidth (MHz)	35.670	35.870
Measurement uncertainty (kHz)	<± 53.05	

Antenna 4:

	Channel 151 5755 MHz	Channel 159 5795 MHz
6 dB bandwidth (MHz)	35.470	36.290
Measurement uncertainty (kHz)	<± 53.05	

Mode : 802.11ac VHT80 - 80MHz

Antenna 1:

	Channel 155 5775 MHz
6 dB bandwidth (MHz)	75.600
Measurement uncertainty (kHz)	<± 103.10

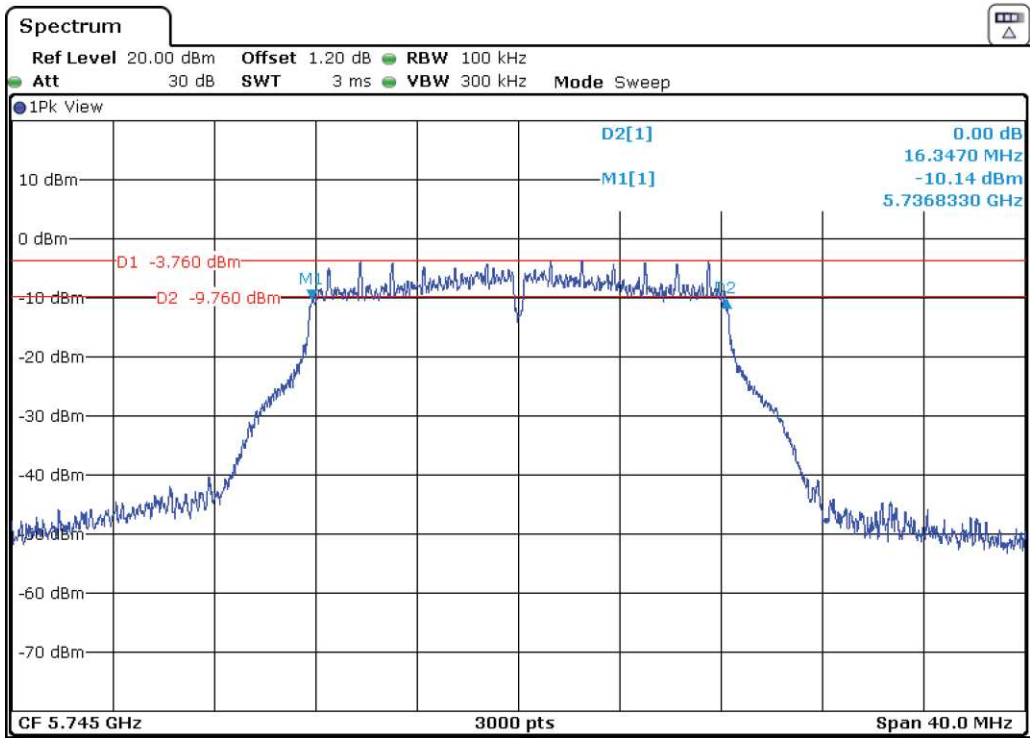
Antenna 4:

	Channel 155 5775 MHz
6 dB bandwidth (MHz)	75.860
Measurement uncertainty (kHz)	<± 103.10

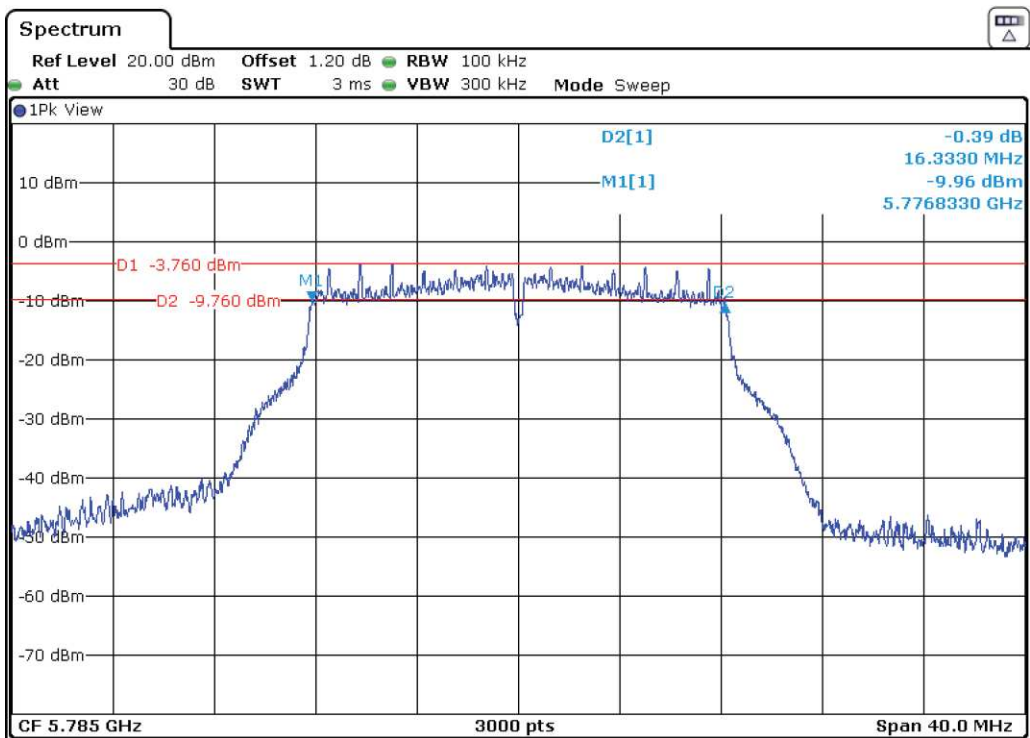
Verdict: PASS

WLAN0 - CORE 0 – SISO - Antenna port 2
Mode: 802.11a - 20MHz

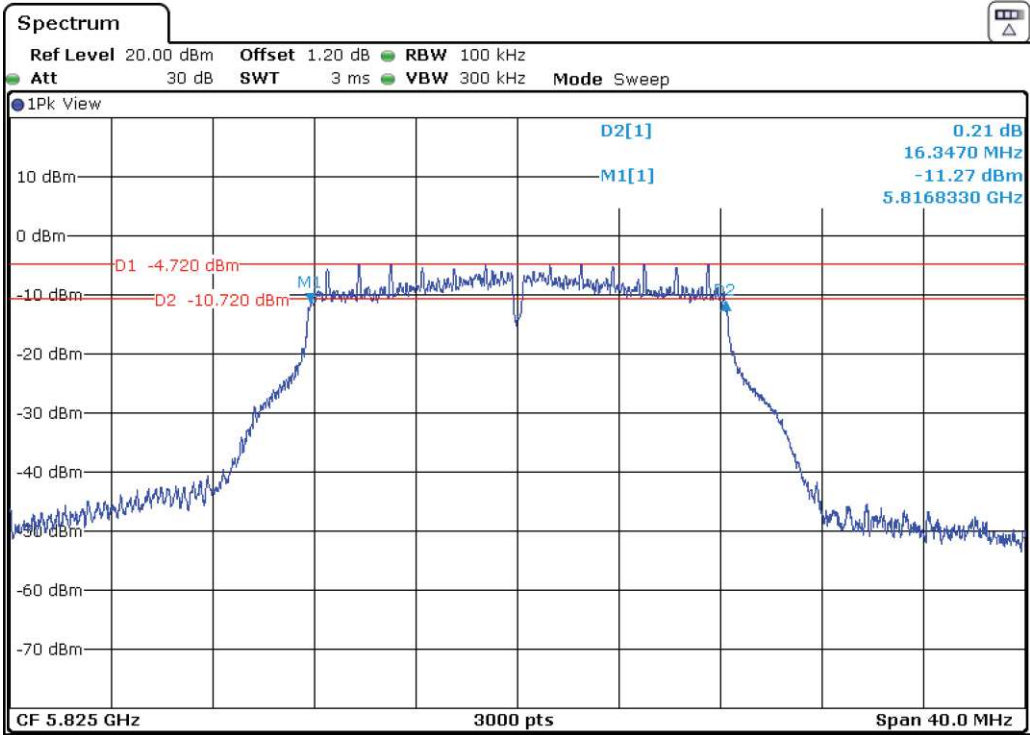
Channel 149



Channel 157

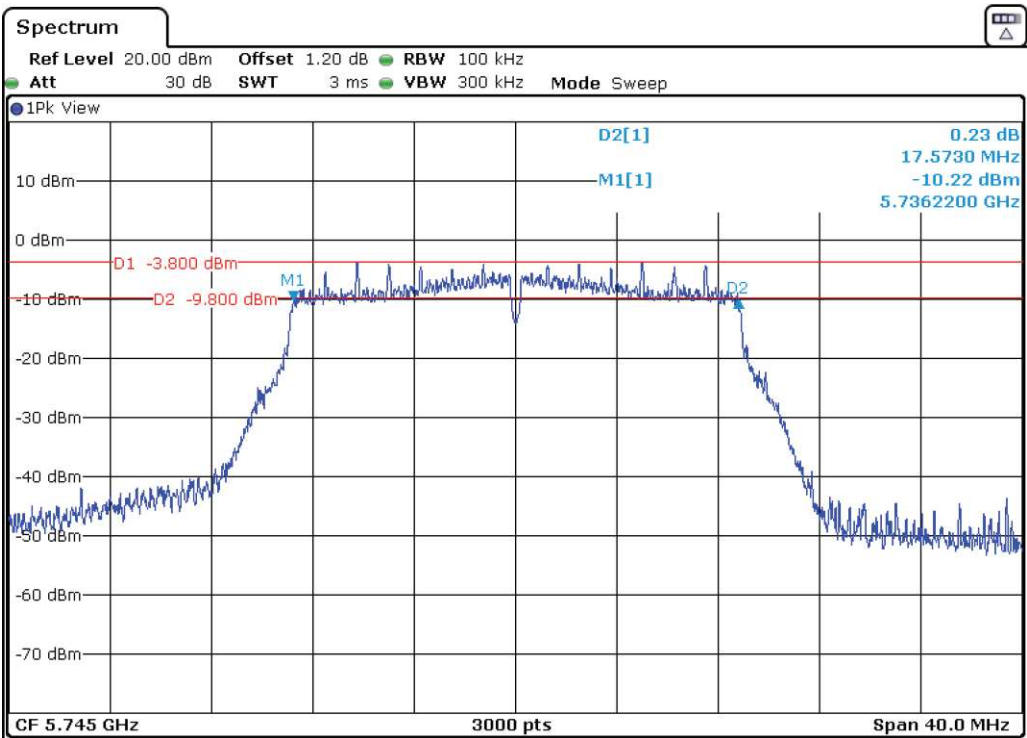


Channel 165

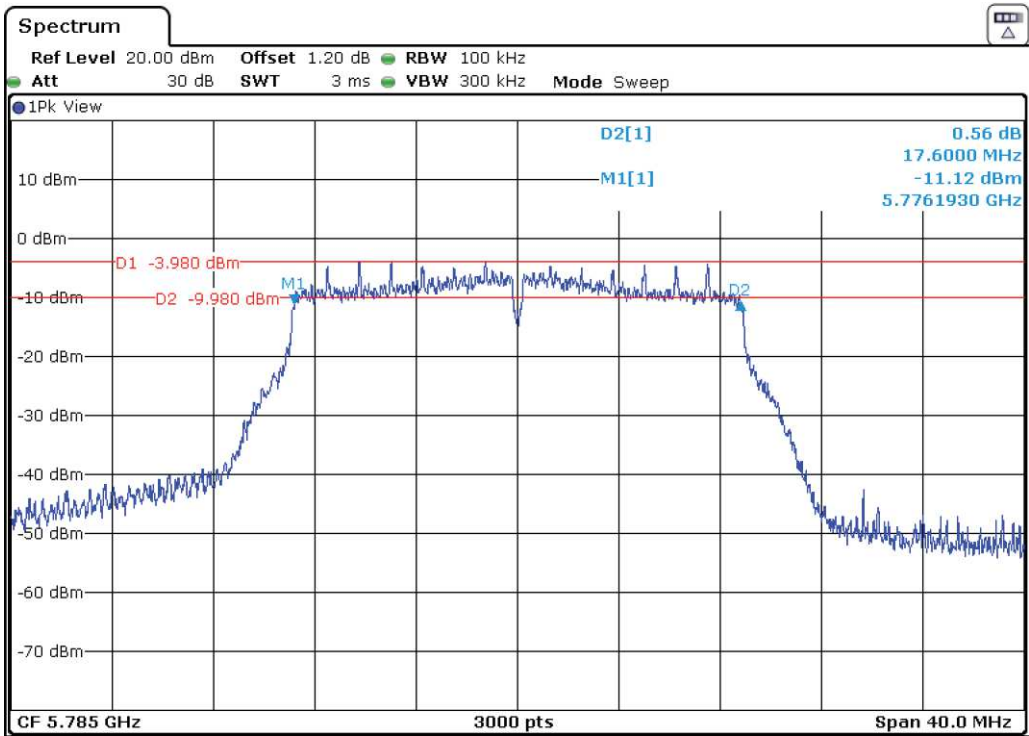


Mode: 802.11n HT20 - 20MHz

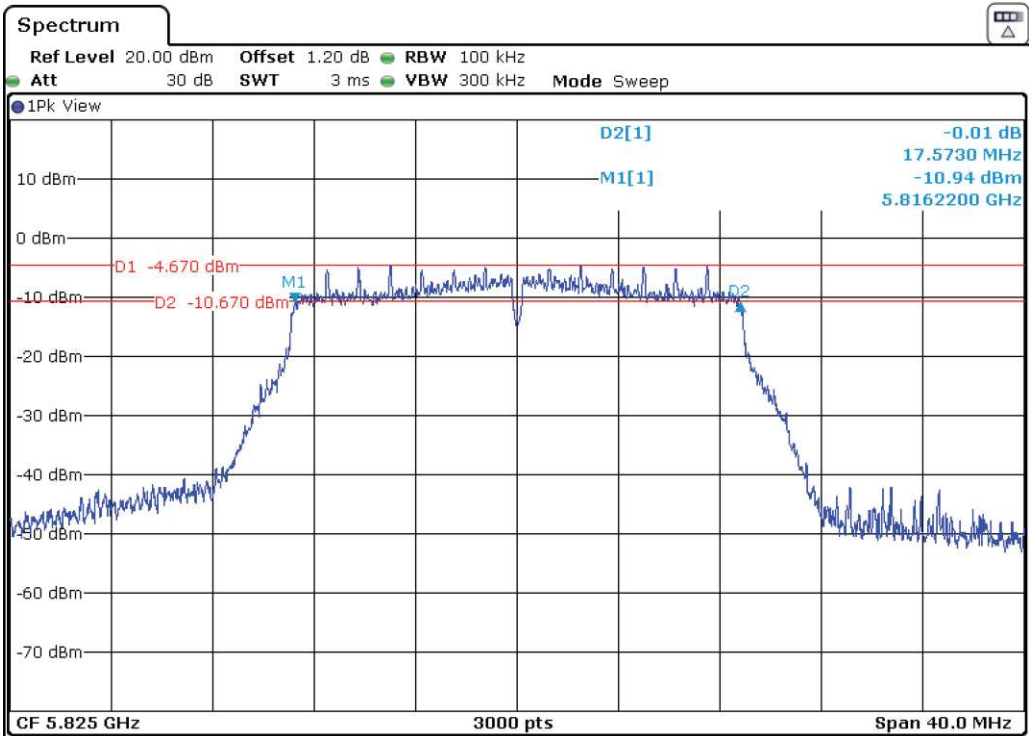
Channel 149



Channel 157

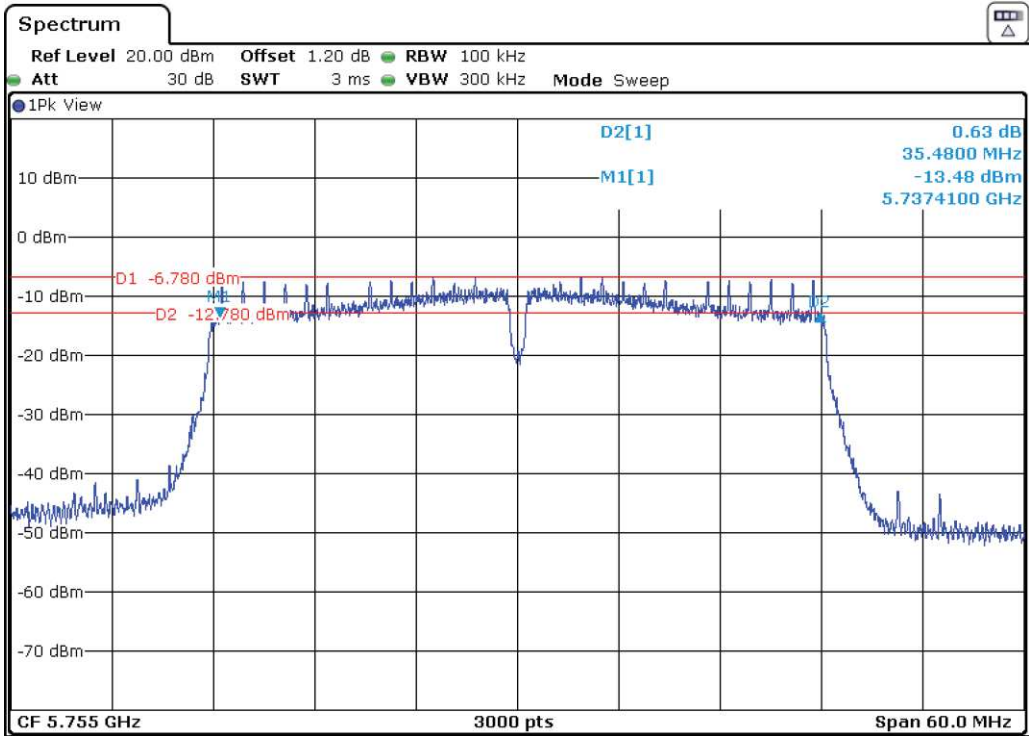


Channel 165

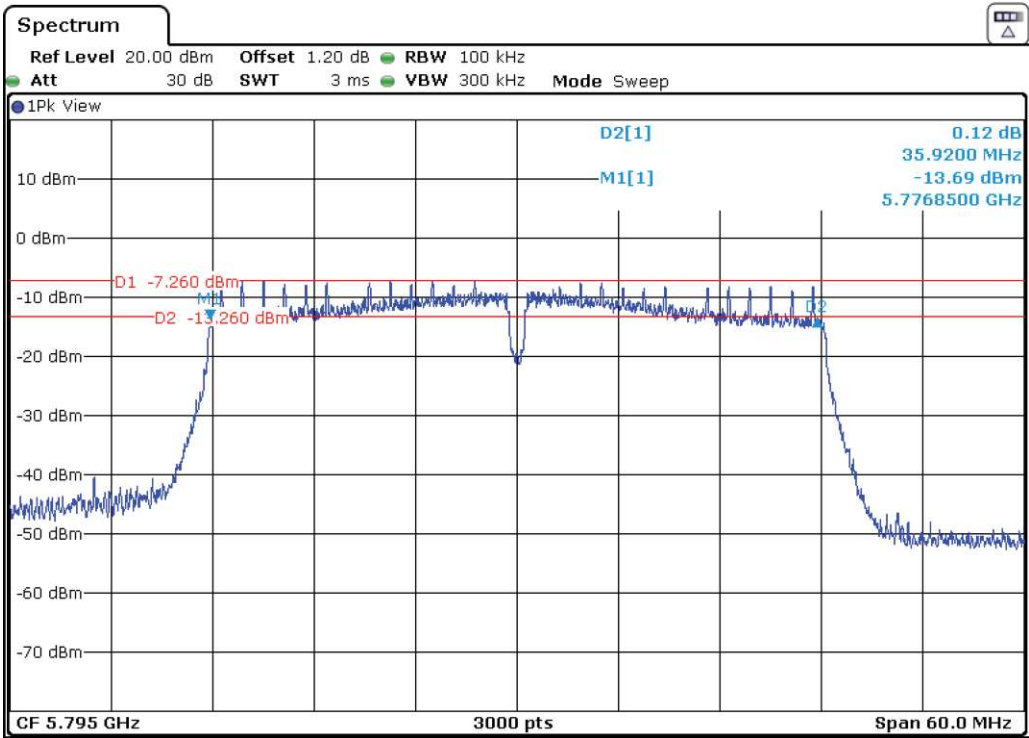


Mode: 802.11n HT40 - 40MHz

Channel 151

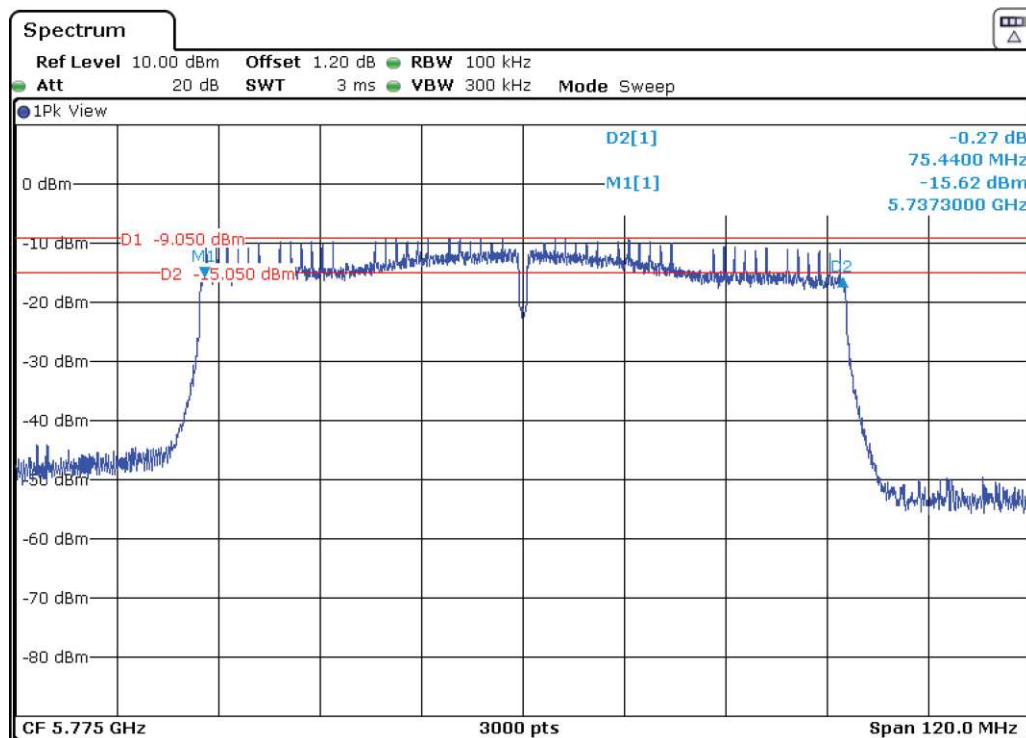


Channel 159



Mode: 802.11ac VHT80 - 80MHz

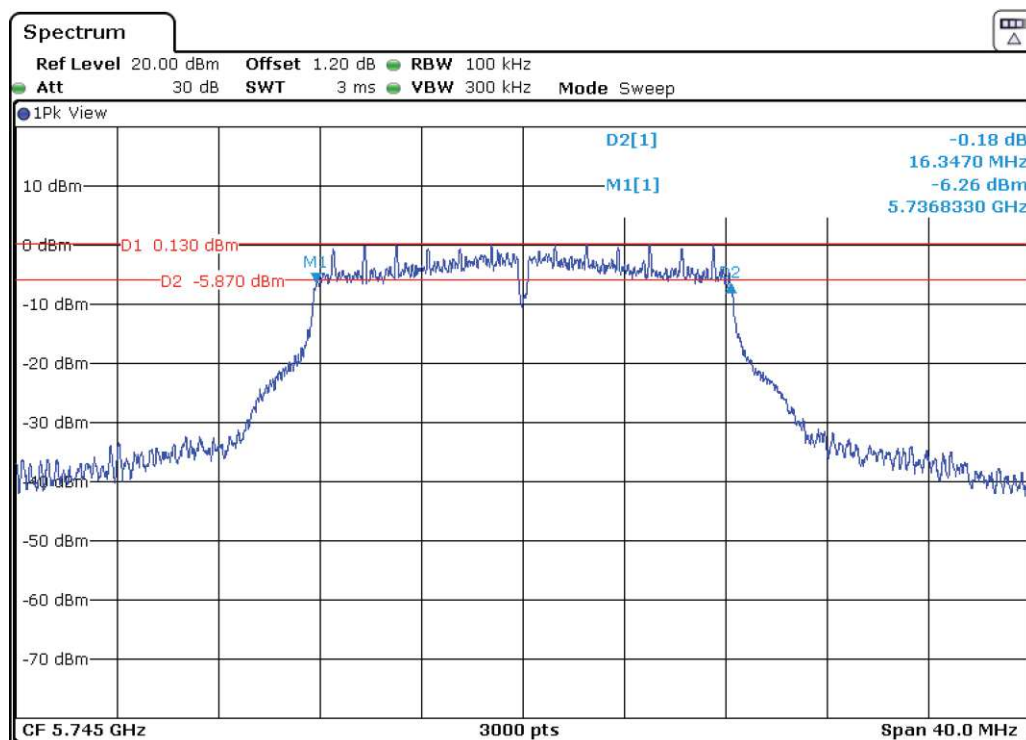
Channel 155



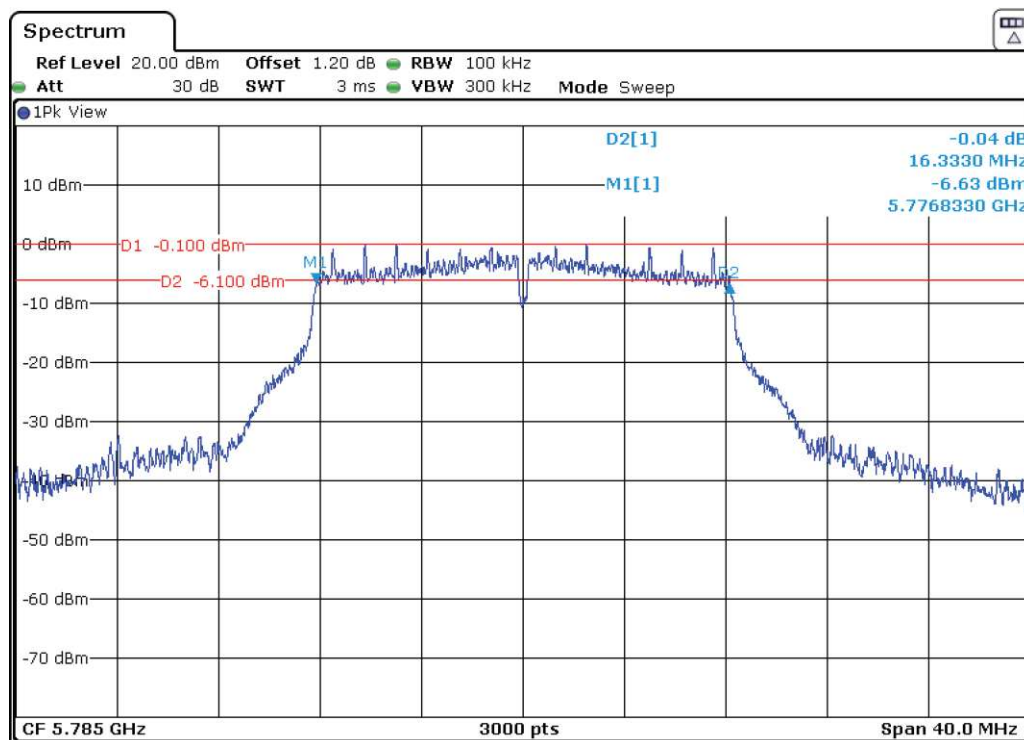
WLAN 1 - CORE 0 – SISO - Antenna port 3

Mode: 802.11a - 20MHz

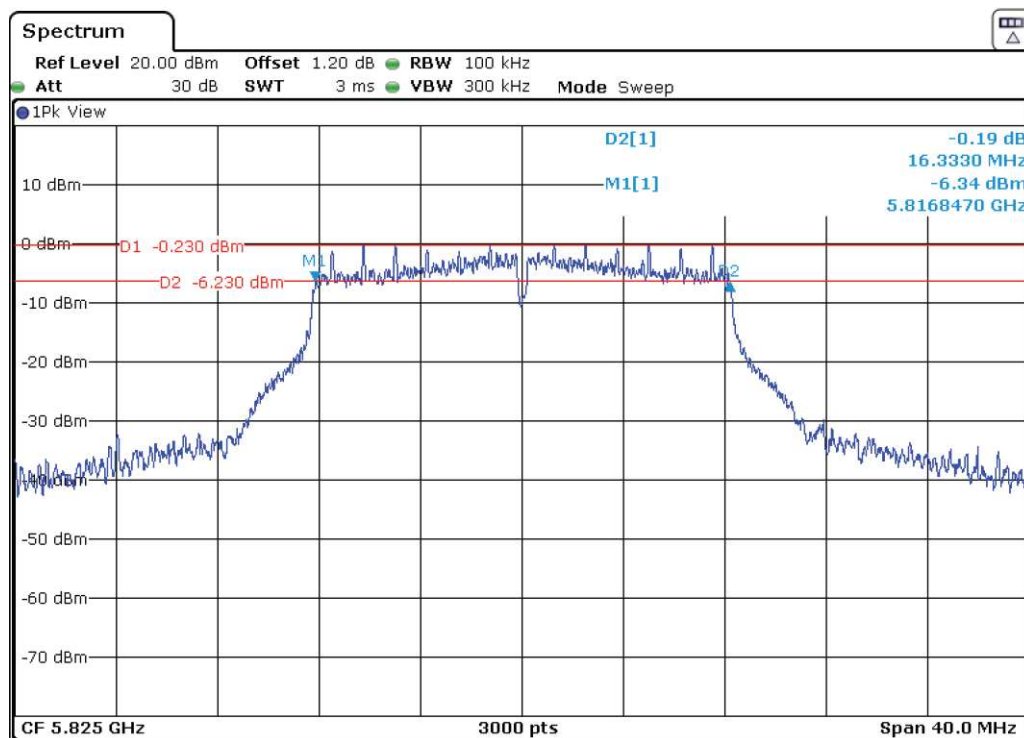
Channel 149



Channel 157

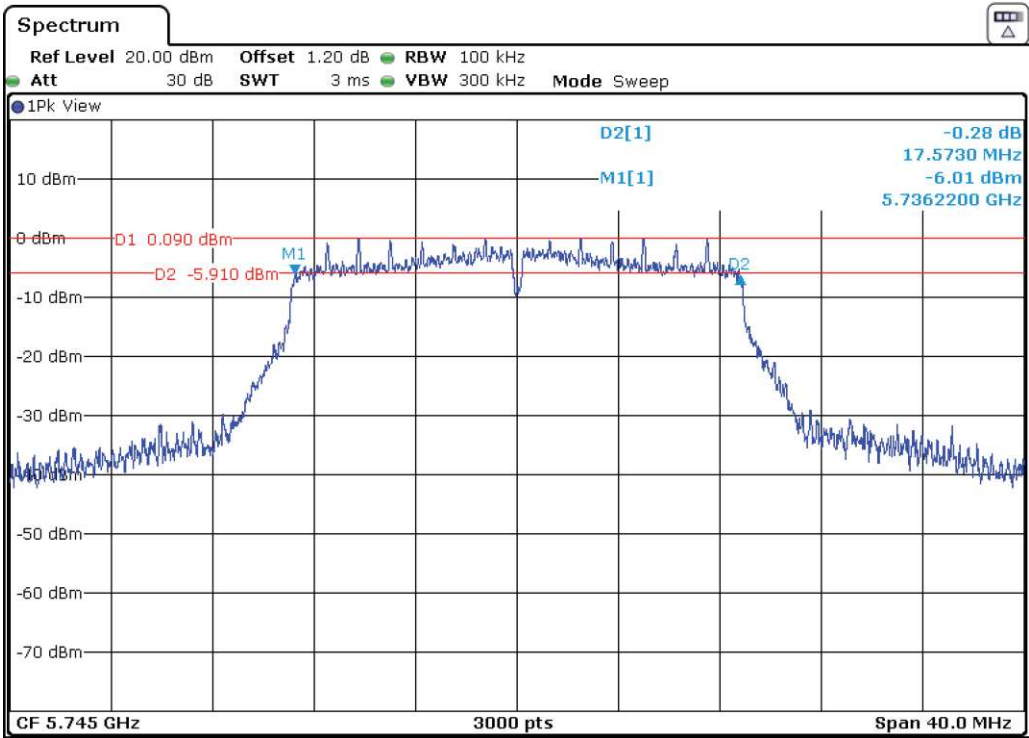


Channel 165

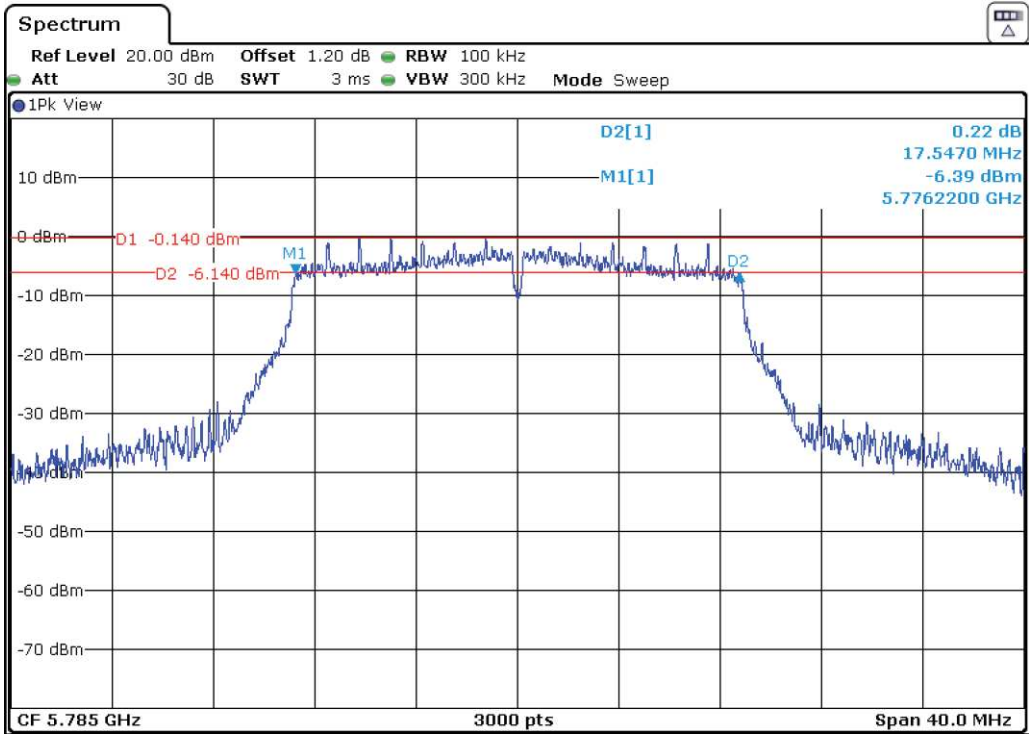


Mode: 802.11n HT20 - 20MHz

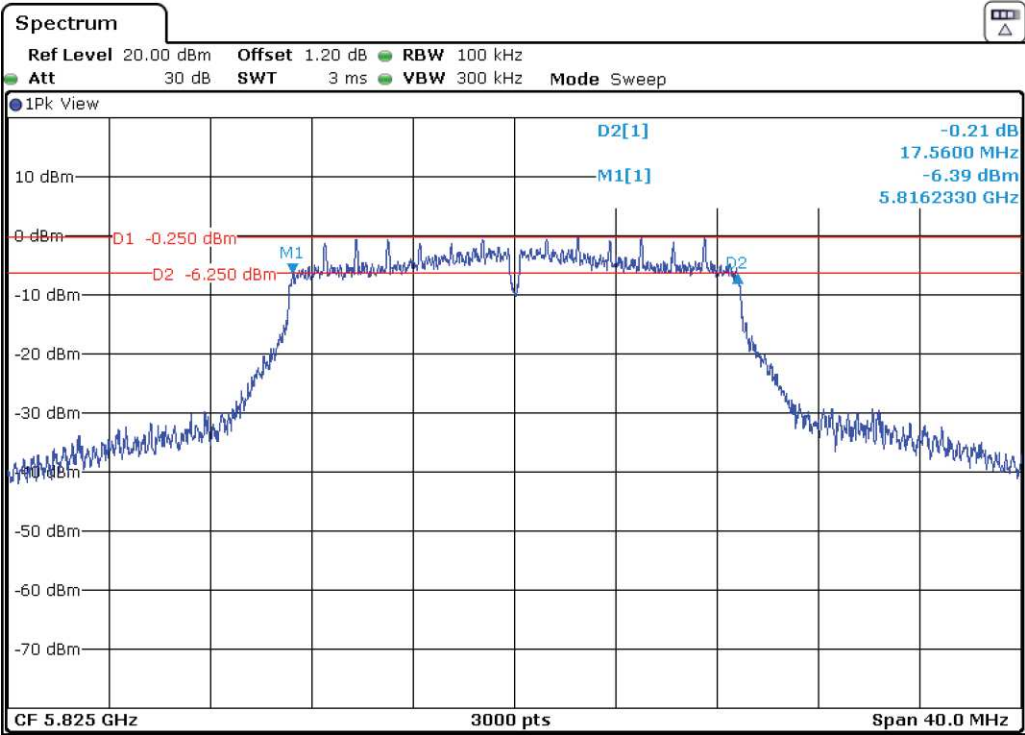
Channel 149



Channel 157

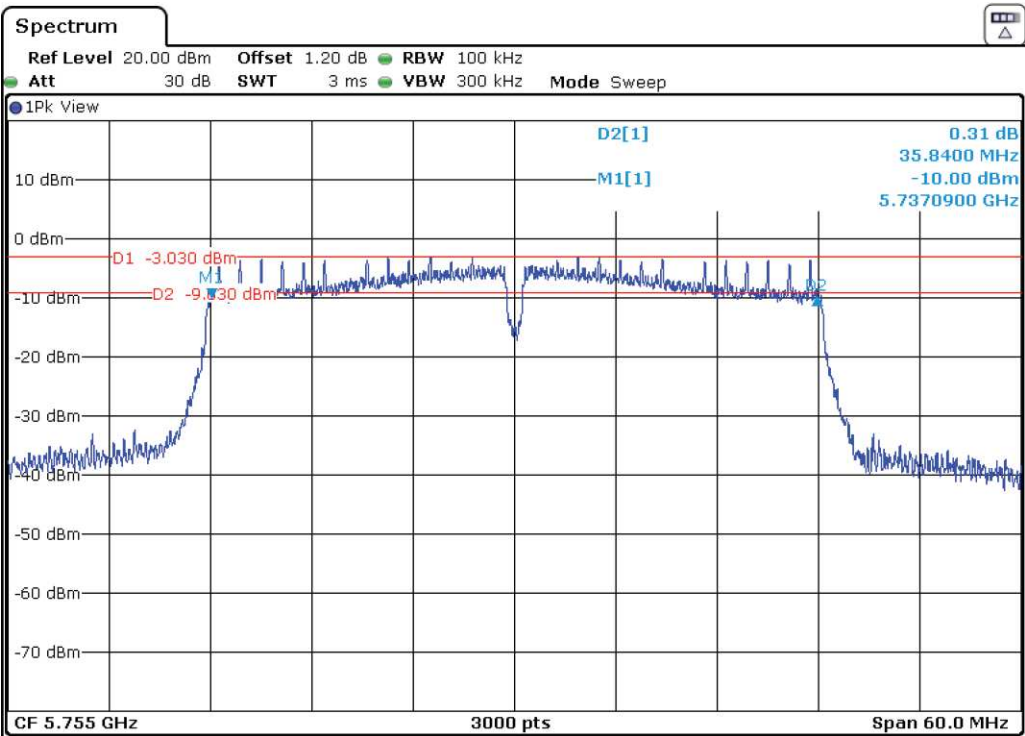


Channel 165

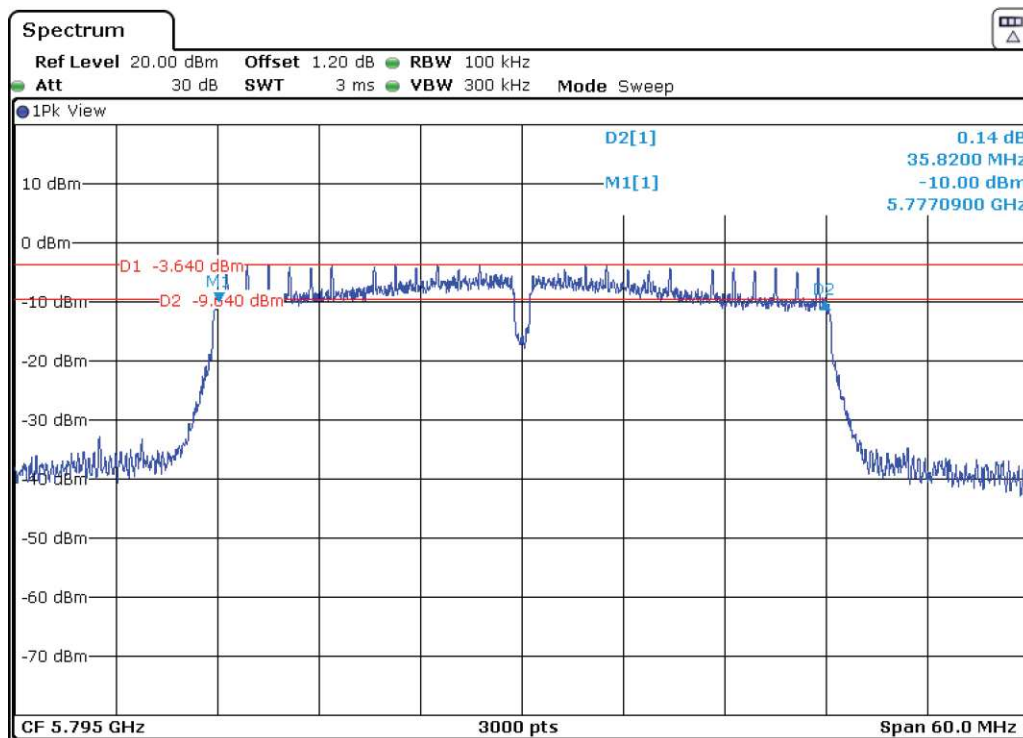


Mode: 802.11n HT40 - 40MHz

Channel 151

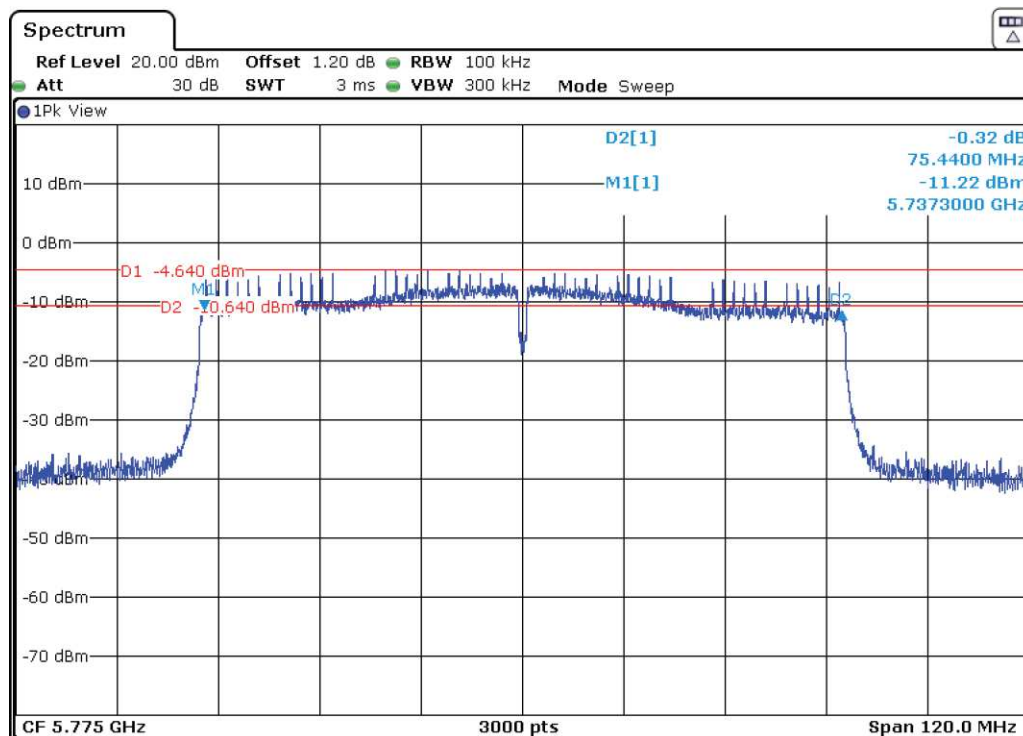


Channel 159



Mode: 802.11ac VHT80 - 80MHz

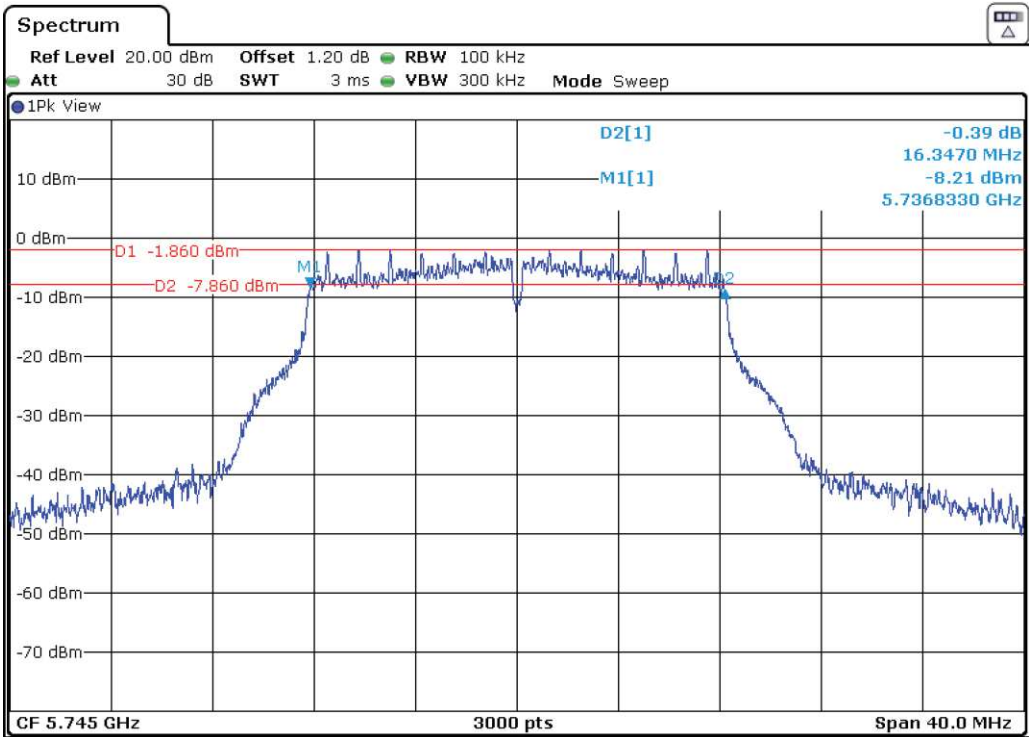
Channel 155



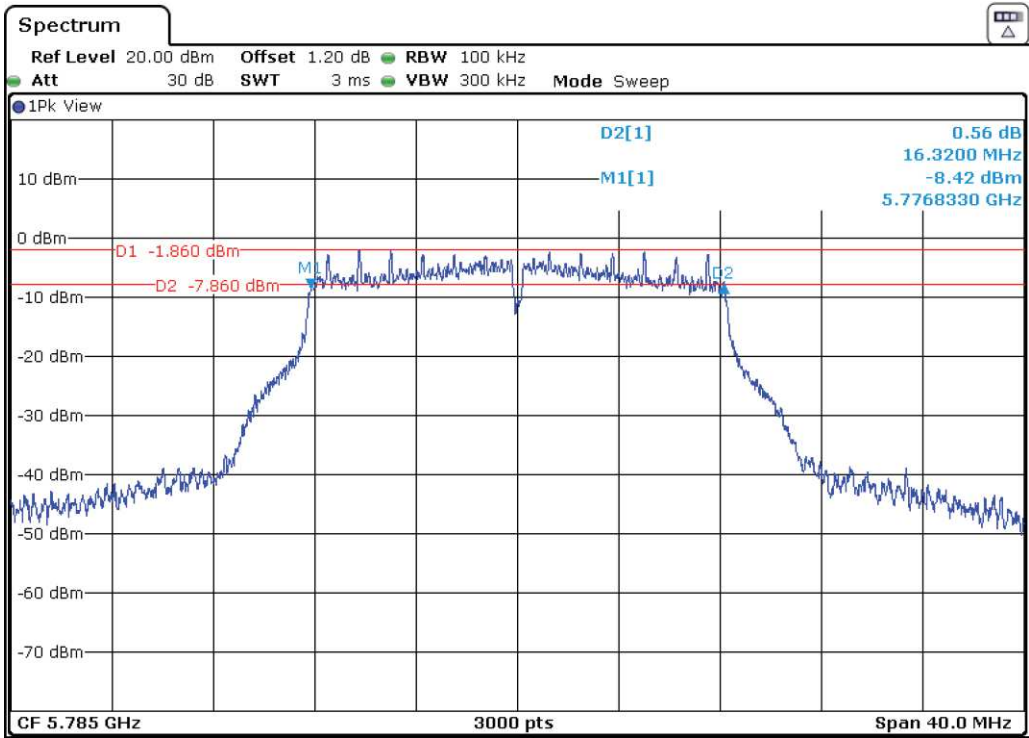
WLAN 1 - CORE 1 – SISO - Antenna port 4

Mode: 802.11a - 20MHz

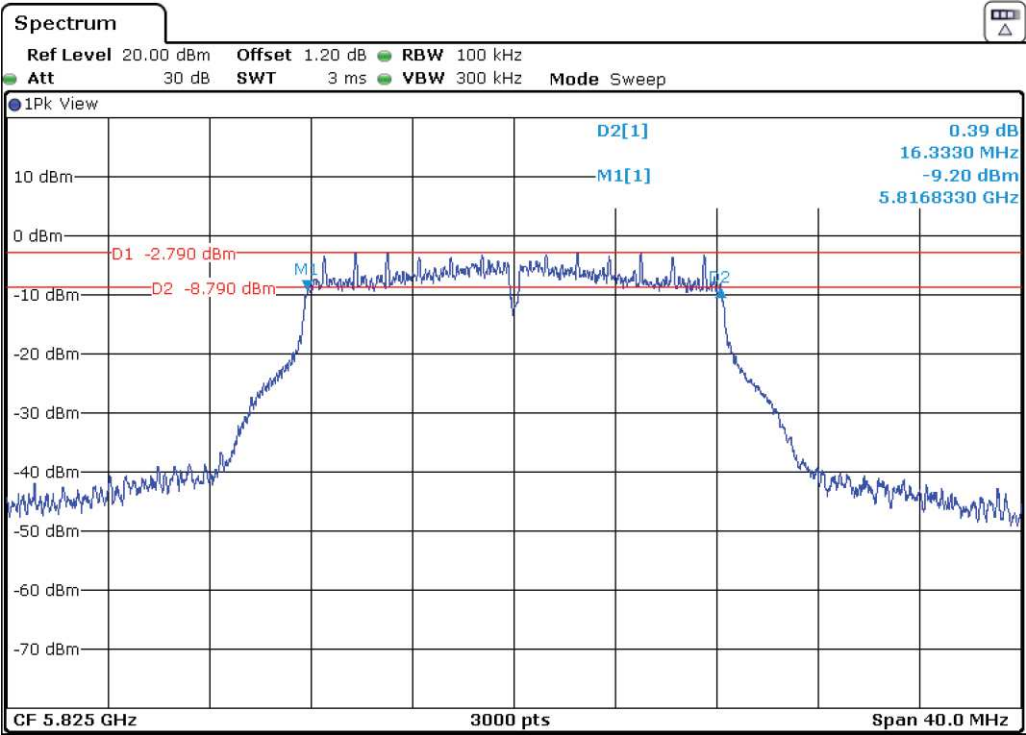
Channel 149



Channel 157

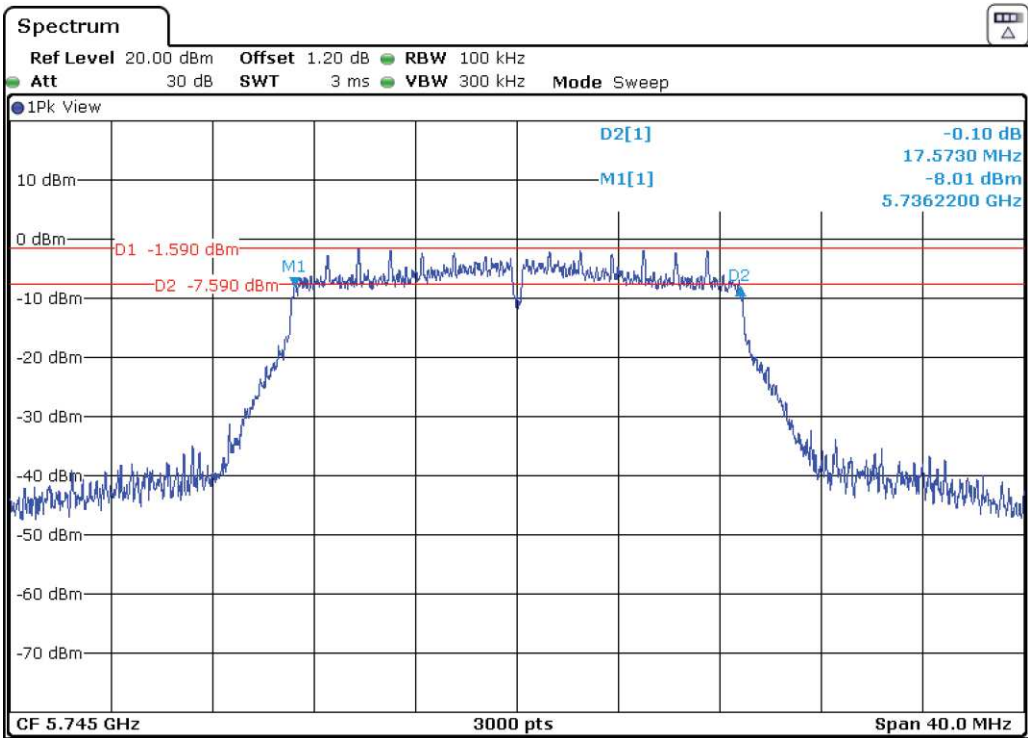


Channel 165

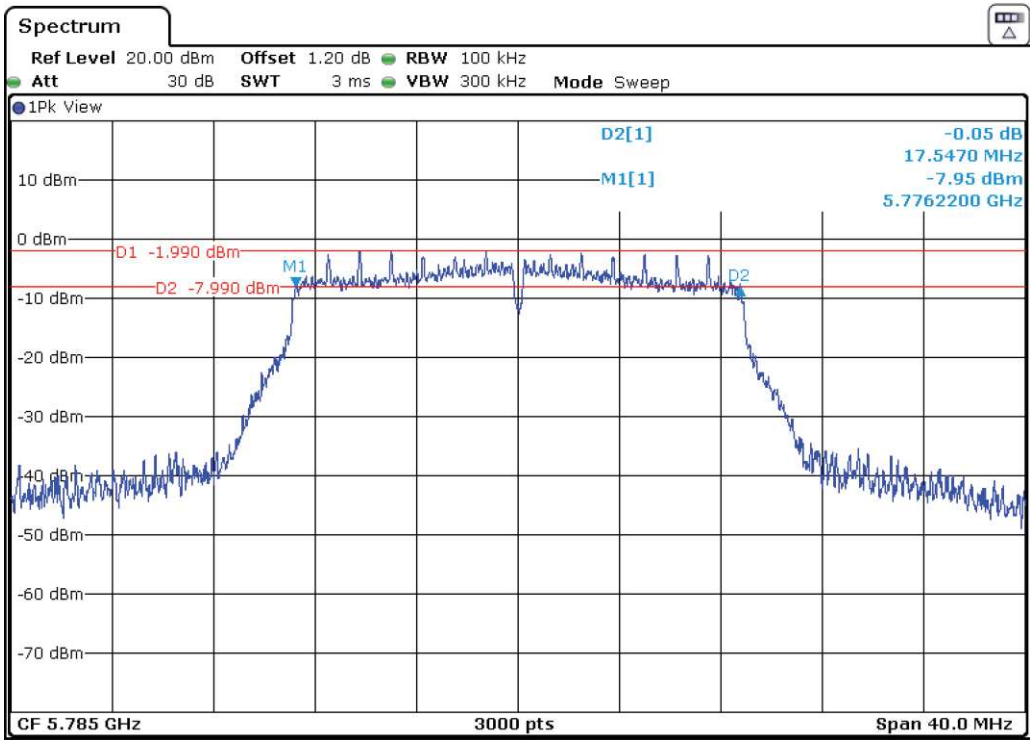


Mode: 802.11n HT20 - 20MHz

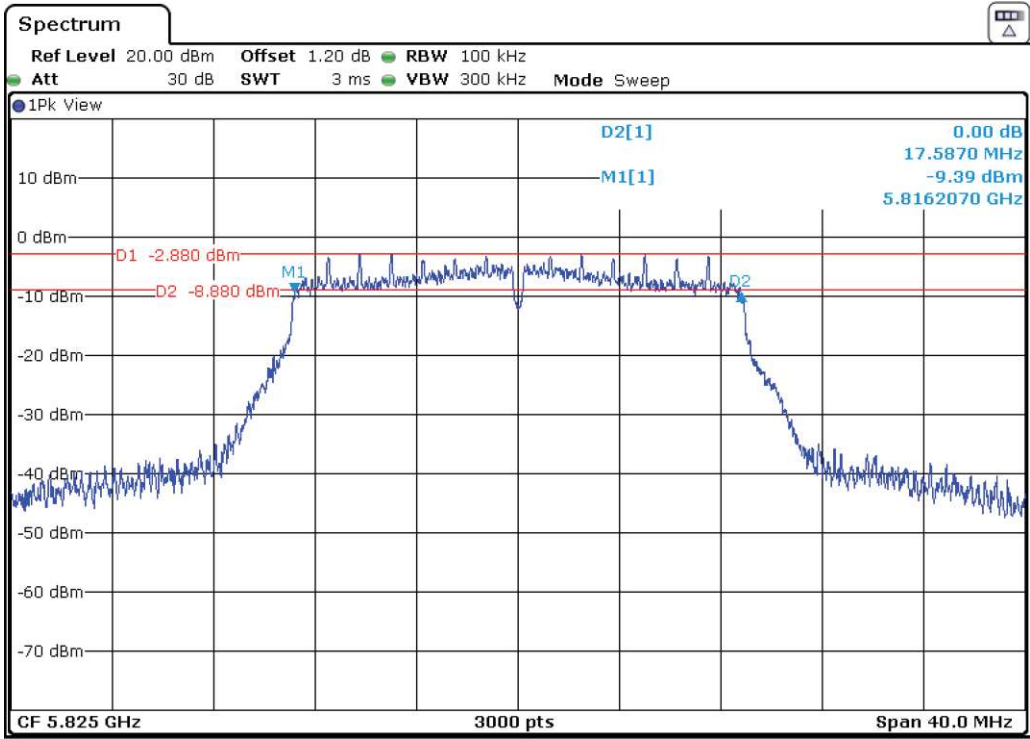
Channel 149



Channel 157

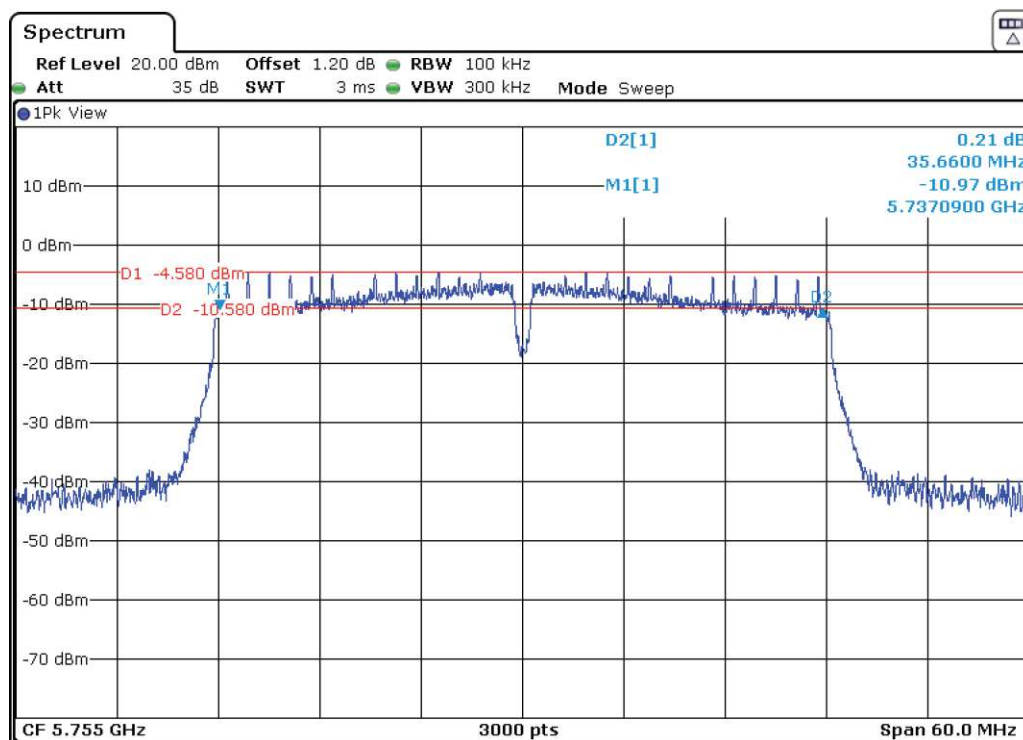


Channel 165

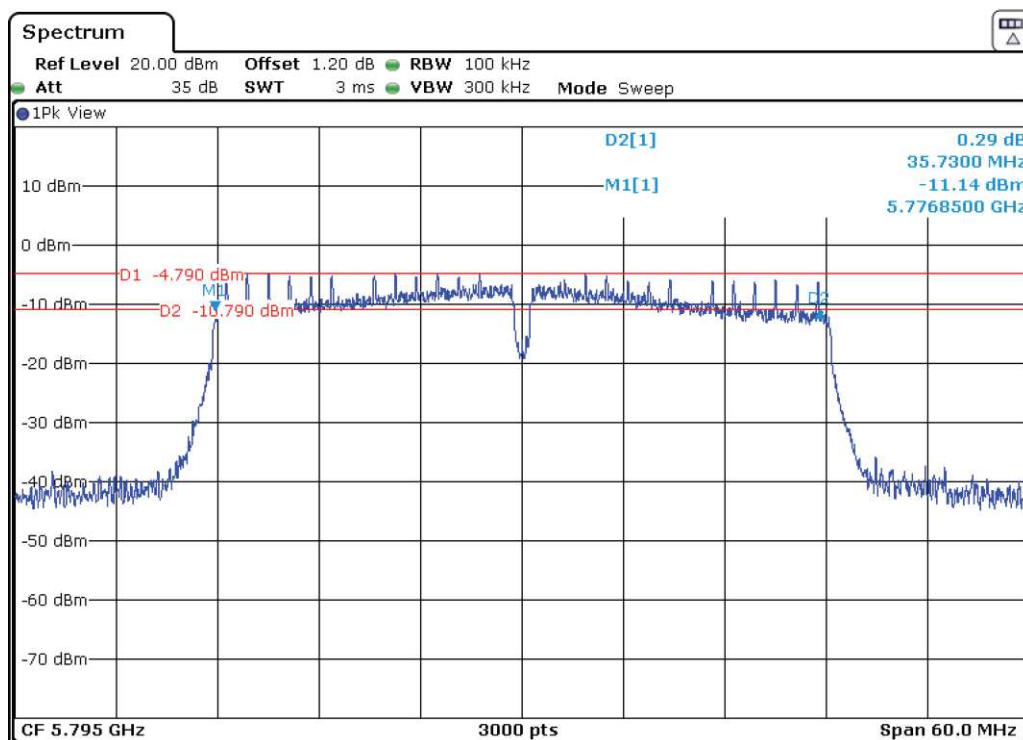


Mode: 802.11n HT40 - 40MHz

Channel 151

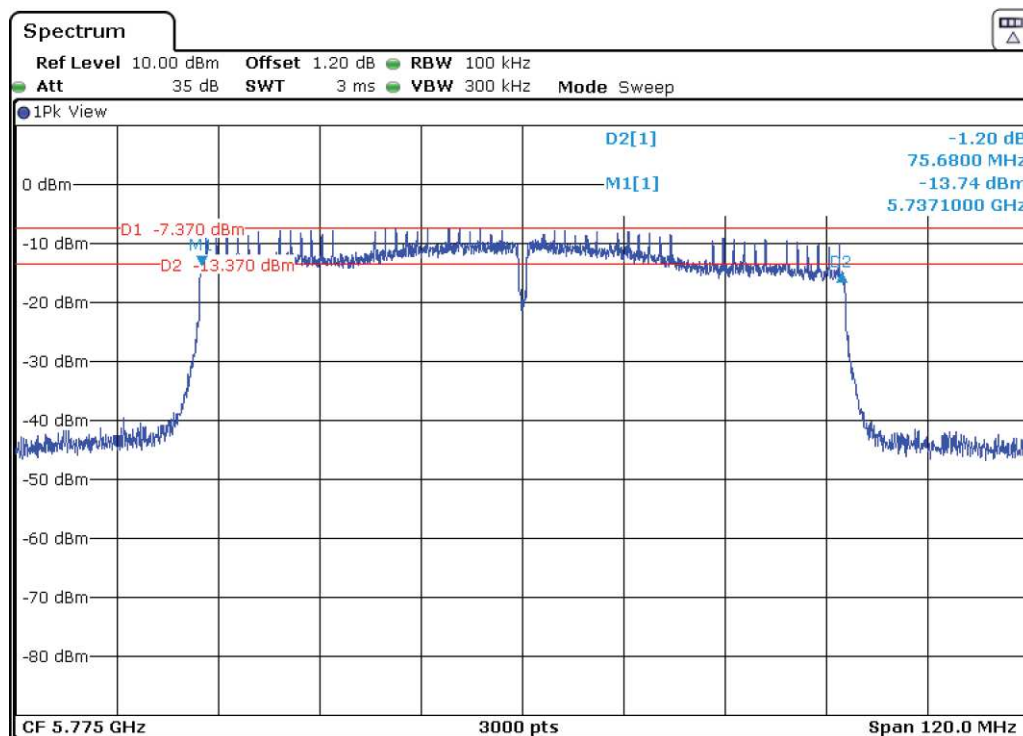


Channel 159



Mode: 802.11ac VHT80 - 80MHz

Channel 155

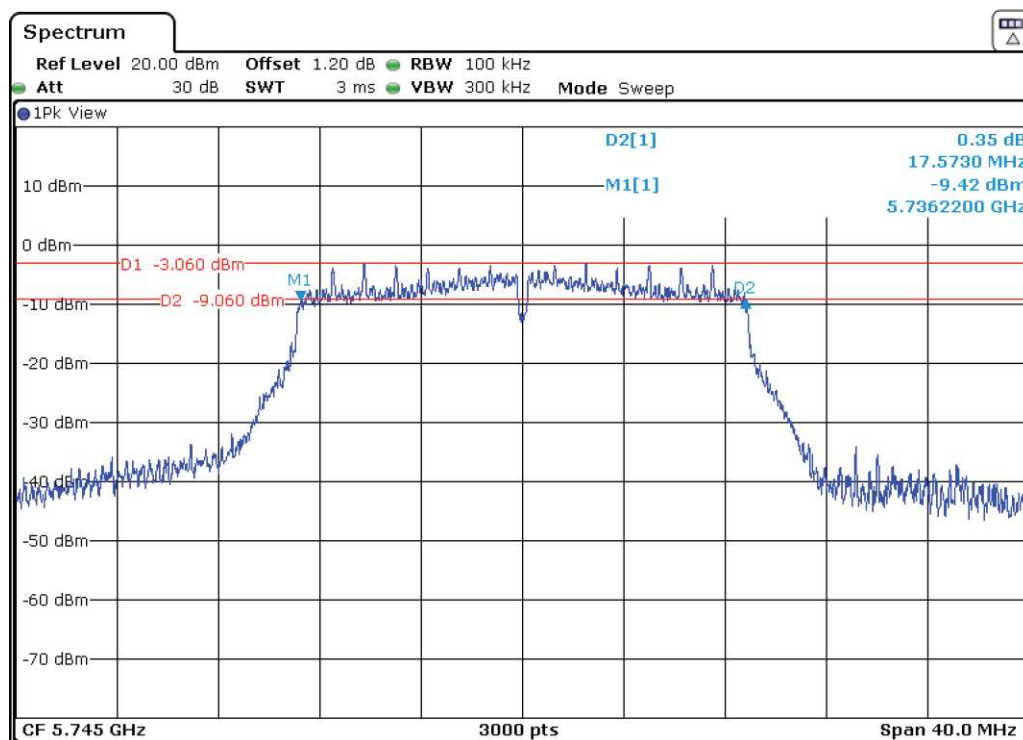


WLAN 1 – CORE2 (CORE0+ CORE1) - MIMO – Antenna ports 1 - 4

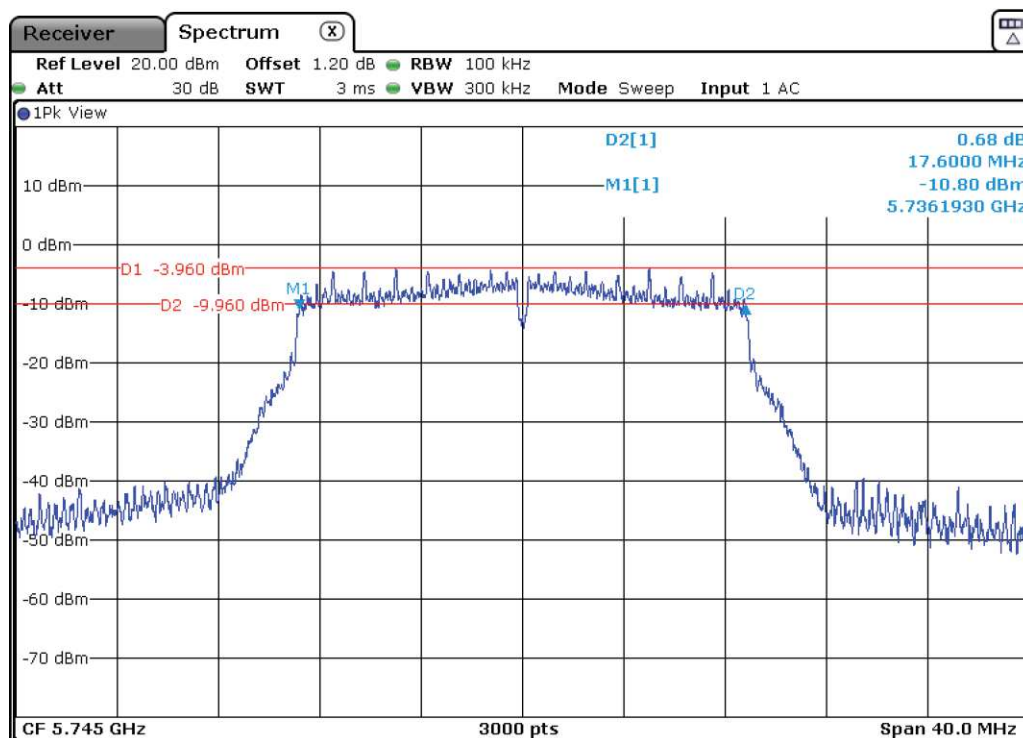
Mode: 802.11n HT20 - 20MHz

Channel 149

Antenna 1

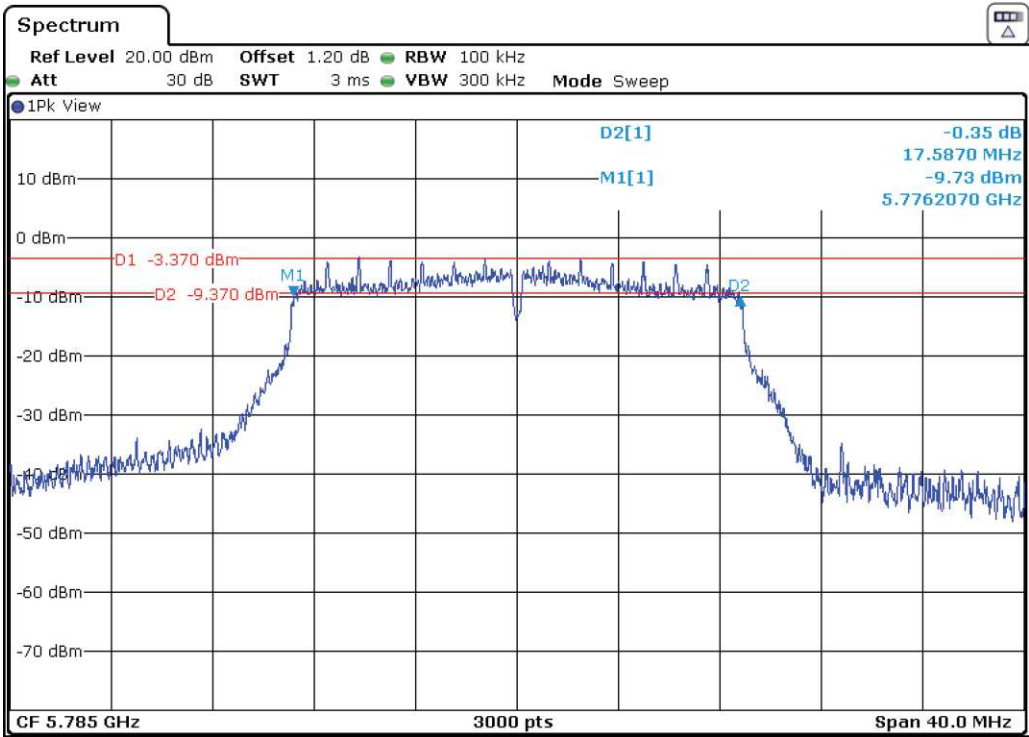


Antenna 4

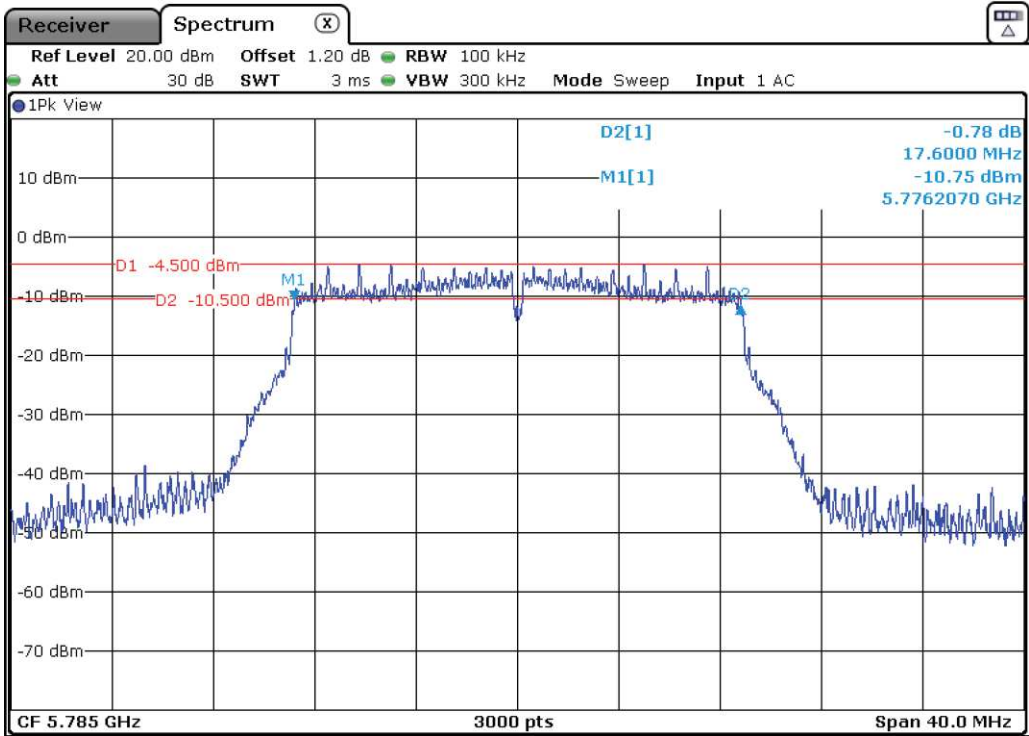


Channel 157

Antenna 1

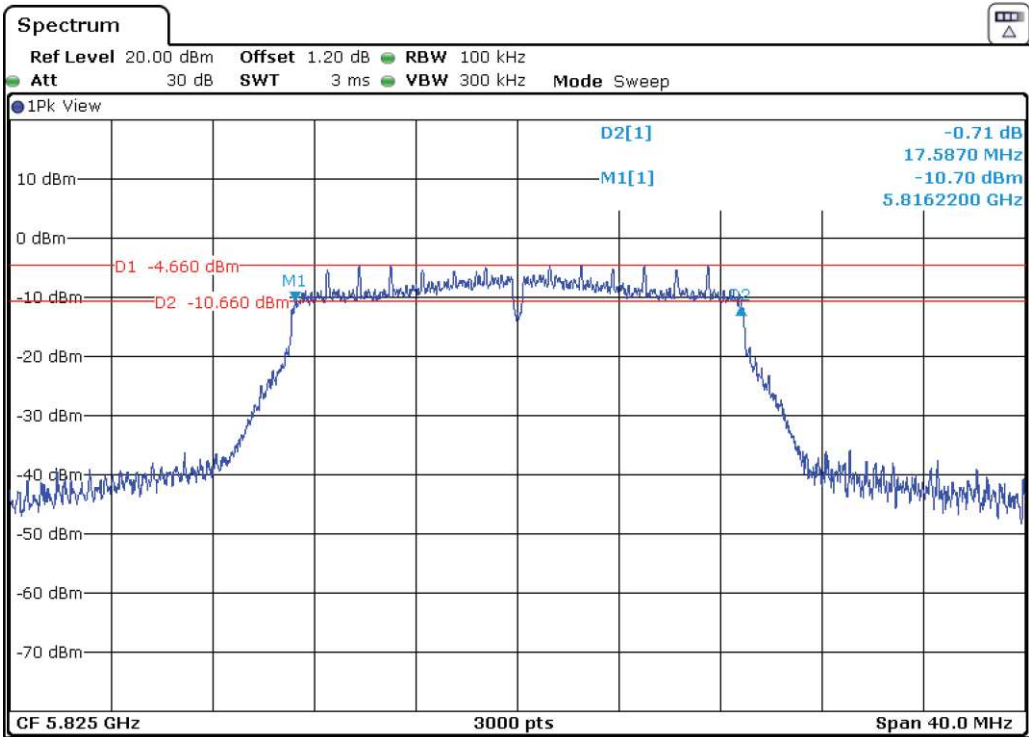


Antenna 4

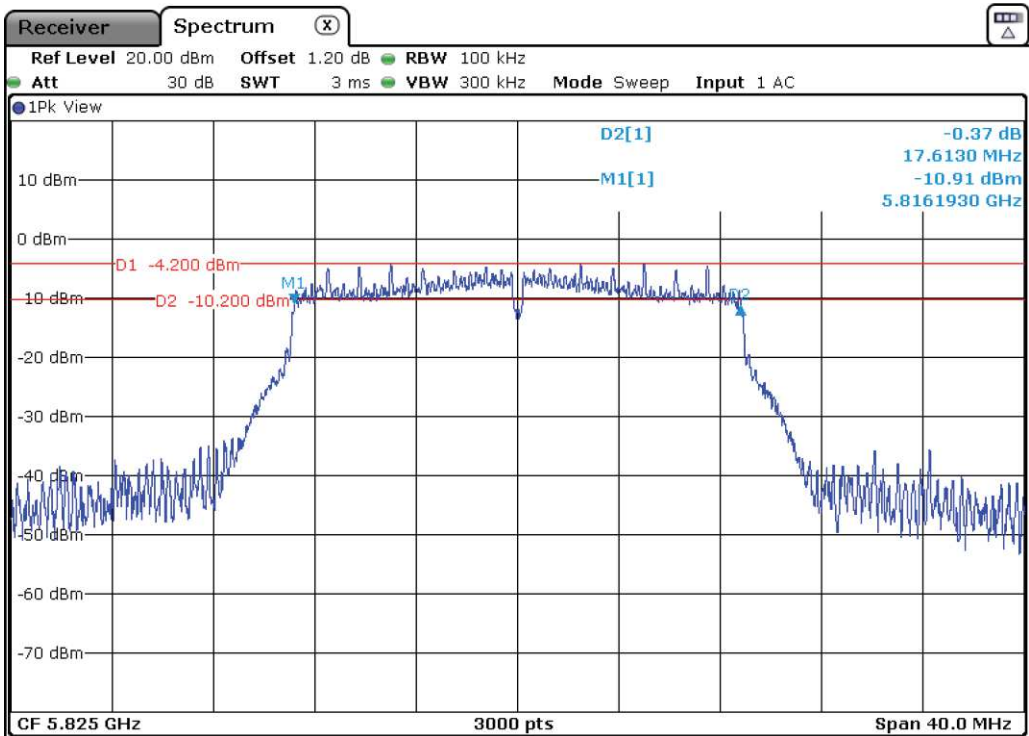


Channel 165

Antenna 1



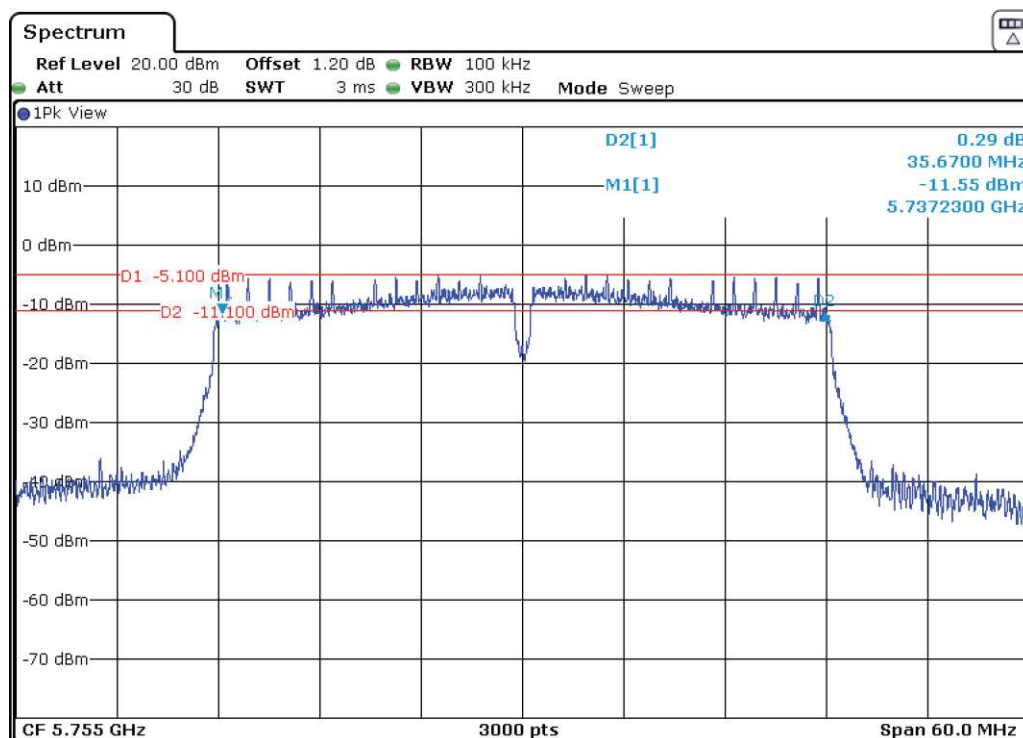
Antenna 4



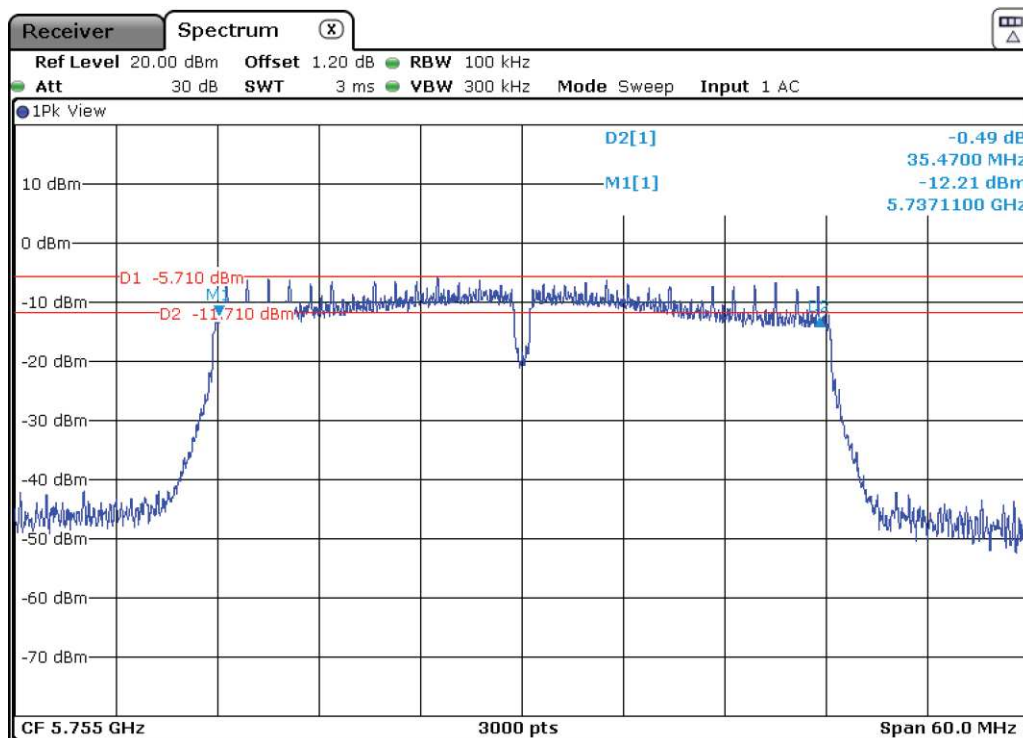
Mode: 802.11n HT40 - 40MHz

Channel 151

Antenna 1

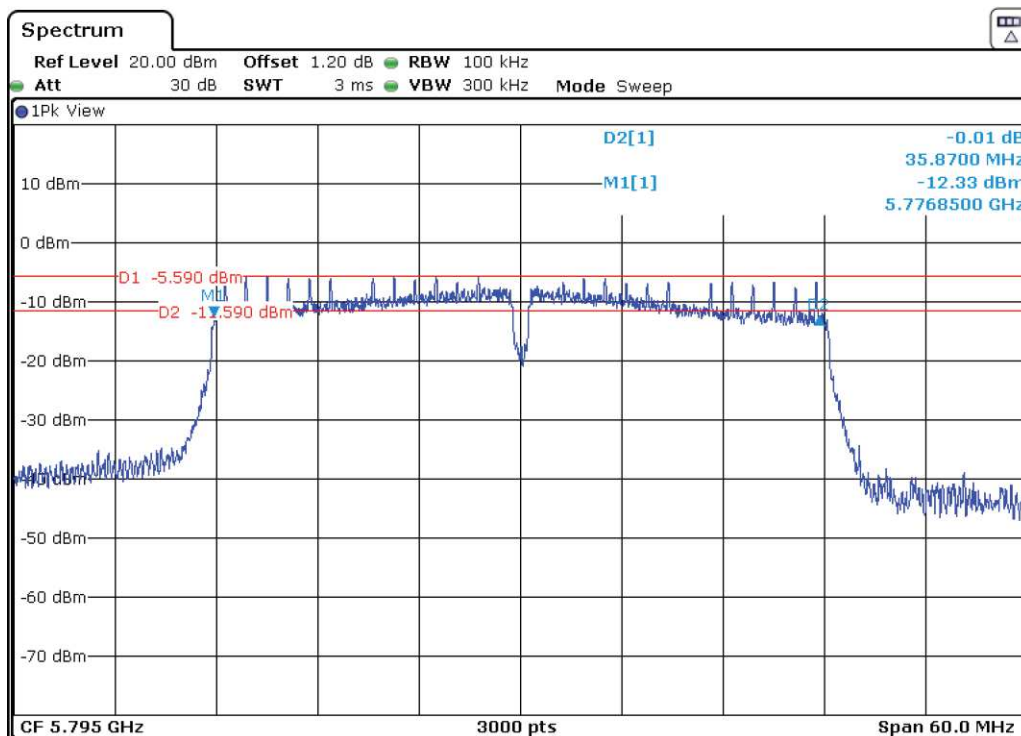


Antenna 4

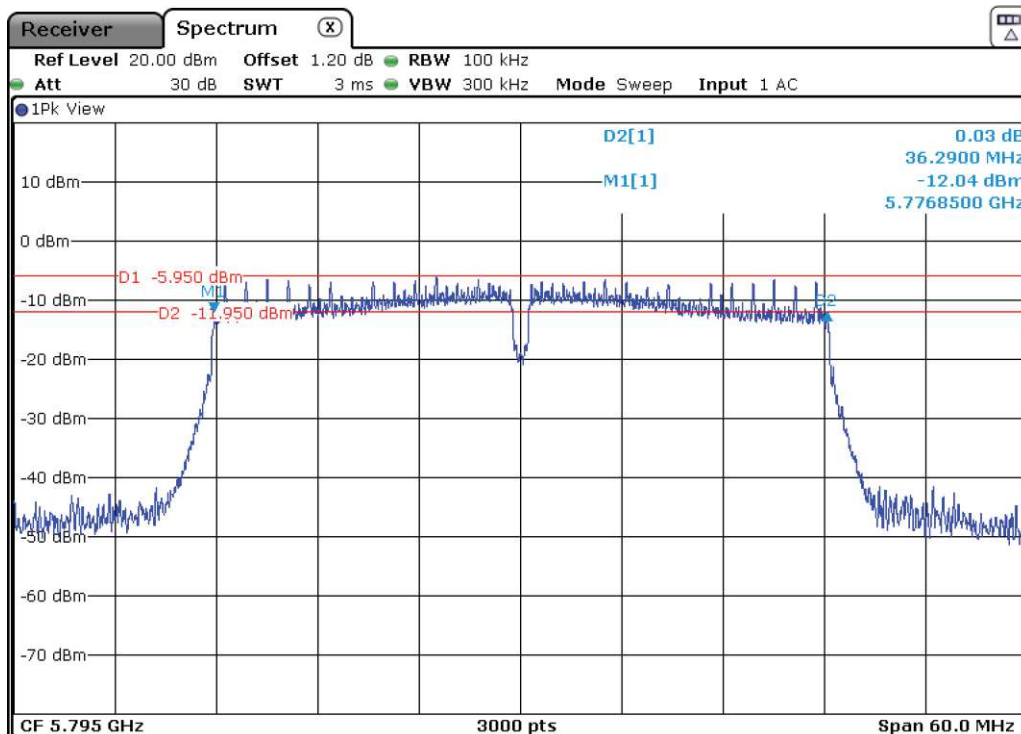


Channel 159

Antenna 1



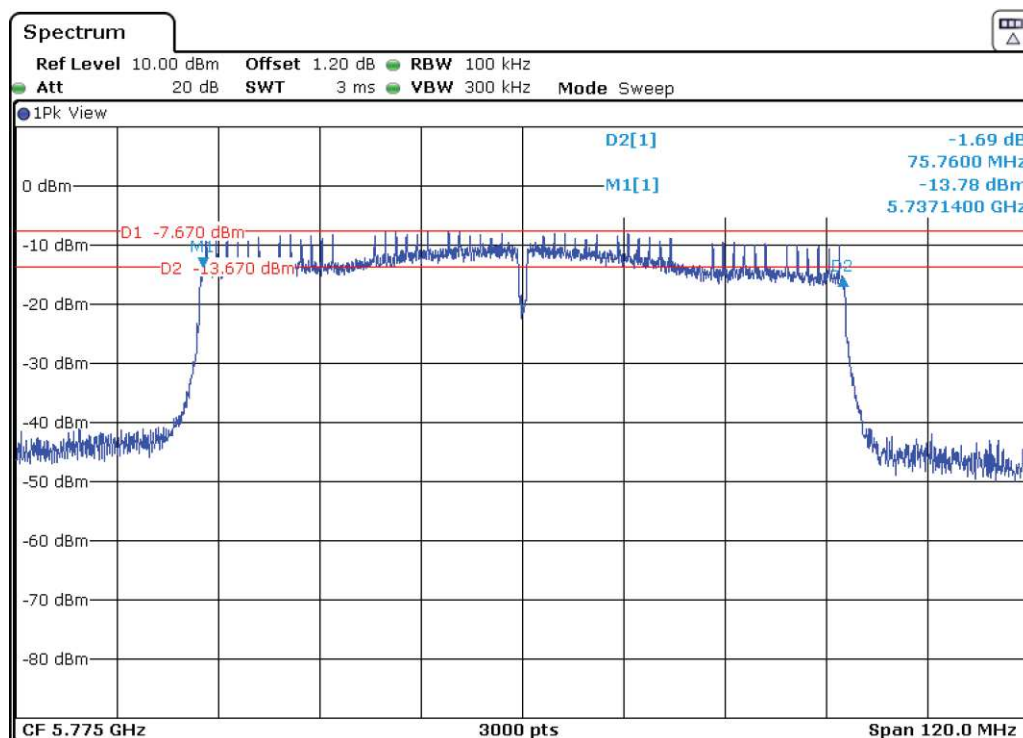
Antenna 4



Mode: 802.11ac VHT80 - 80MHz

Channel 155

Antenna 1



Antenna 4

