



FCC LISTED,
REGISTRATION NUMBER:
720267

Informe de ensayo n°:
Test report No:

ISED LISTED
REGISTRATION NUMBER
4621A-2

NIE: 55472RRF.004

Test report

USA FCC Part 15.407 (U-NII), 15.209 CANADA RSS-247, RSS-Gen

Unlicensed National Information Infrastructure Devices. General technical requirements.
Radiated emission limits; general requirements.
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-
Exempt Local Area Network (LE-LAN) Devices.

Identificación del objeto ensayado.....: Identification of item tested	Automotive infotainment System
Marca Trademark	BMW
Modelo y/o referencia tipo Model and /or type reference	MGU
Other identification of the product	FCC ID: T8GMGU IC: 6434A-MGU
Final HW version	1.4
Final SW version	A415_17w46.1-2
Características Features	Bluetooth, WLAN, GNSS.
Fabricante Features	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.407 10-1-17 Edition: Unlicensed National Information Infrastructure Devices. General technical requirements. Band U-NII-3 (5725 MHz – 5850 MHz). USA FCC Part 15.209 10-1-17 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 4 (November 2014). Guidance for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General UNII Test Procedures New Rules v02r01 dated 12/14/2017. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Resultado.....: Summary	IN COMPLIANCE

Aprobado por (nombre / cargo y firma) Approved by (name / position & signature)	A. Llamas RF Lab. Manager		Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ Fecha: 2018.02.27 09:06:41 +01'00'
Fecha de realización Date of issue	2018-02-27		
Formato de informe No. Report template No	FDT08_20		

Index

Competences and guarantees.....	4
General conditions.....	4
Uncertainty	4
Usage of samples.....	5
Test sample description	5
Identification of the client	5
Testing period.....	6
Environmental conditions.....	6
Testing verdicts	8
Appendix A – Test result for 5.725 GHz – 5.85 GHz band	9

Competences and guarantees

DEKRA Testing and Certification is a testing laboratory accredited by the National Accreditation Body (ENAC - Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISED 4621A-2.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification at the time of performance of the test.

DEKRA Testing and Certification is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA Testing and Certification.

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification and the Accreditation Bodies.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the DEKRA Testing and Certification internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: **the client**

Sample S/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
54472/011	Automotive infotainment System	MGU	B298J70H7524619	2017-11-30
55472/002	Test Board	---	---	2017-11-30
55472/003	Ethernet/USB adapter	EU-4306	EU430677MA00946	2017-11-30
55472/005	Ethernet cable	---	---	2017-11-30
55472/034	Harness + Antennas	---	---	2017-12-07

1. Sample S/01 has undergone following test(s).

All radiated tests indicated in appendix A.

Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
54472/011	Automotive infotainment System	MGU	B298J70H7524619	2017-11-30
55472/002	Test Board	---	---	2017-11-30
55472/003	Ethernet/USB adapter	EU-4306	EU430677MA00946	2017-11-30
55472/004	Harness	---	---	2017-11-30
55472/005	Ethernet cable	---	---	2017-11-30

1. Sample S/02 has undergone following test(s).

All conducted tests indicated in appendix A.

Test sample description

The test sample consists of an automotive head unit to be installed in cars with the following features: Bluetooth, WLAN and GNSS.

Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH
BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY

Testing period

The performed test started on 2017-12-12 and finished on 2018-01-02.

The tests have been performed at DEKRA Testing and Certification.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 k Ω
Reference resistance to earth	< 1 Ω

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 k Ω
Reference resistance to earth	< 1 Ω
Normal site attenuation (NSA)	< ± 4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

Remarks and comments

- 1; The tests have been performed by the technical personnel: Pedro Parada, Carolina Postigo and José Carlos Luque.
- 2: The compliance is checked through a description of how this requirement is met that is provided by the applicant.
- 3: Used instrumentation:

Conducted Measurements

	Last Cal. date	Cal. due date
1. Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07
2. Power supply DC 30 V/ 5 A U8002A KEYSIGHT TECHNOLOGIES	---	---
3. Digital Multimeter Fluke 179	2017/05	2018/05

Radiated Measurements

	Last Cal. date	Cal. due date
1. Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2. BiconicalLog antenna ETS LINDGREN 3142E	2017/07	2020/04
3. Multi Device Controller EMCO 2090	N.A.	N.A.
4. Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
5. Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2017/03	2020/03
6. EMI Test Receiver R&S ESU 40	2016/03	2018/03
7. Spectrum analyser Rohde & Schwarz FSW50	2015/12	2017/12
8. RF pre-amplifier 20 MHz- 6 GHz BLNA 0360-01N BONN ELEKTRONIK	2017/07	2018/07
9. RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2016/02	2018/02
10. RF pre-amplifier 18-40 GHz BONN ELEKTRONIK BLMA 1840-1M	2015/12	2017/12

Testing verdicts

Not applicable	N/A
Pass	P
Fail	F
Not measured	N/M

1. 5.725 GHz – 5.85 GHz Band

FCC PART 15 PARAGRAPH		VERDICT			
		NA	P	F	NM
15.407 (a) (3) / RSS-247 Clause 6.2.4.1	Power limits. Maximum output power		P		
15.407 (a) (3) / RSS-247 Clause 6.2.4.1	Maximum power spectral density		P		
15.407 (b) (4), (7) / RSS-247 Clause 6.2.4.2	Radiated Band-edge emissions compliance (Transmitter).		P		
15.407 (e) / RSS-247 Clause 6.2.4.1	6 dB bandwidth.		P		
15.407 (b) (4), (6), (7) / RSS-247 Clause 6.2.4.2	Undesirable radiated emissions (Transmitter)		P		
15.407 (g)	Frequency stability				NM ²

2: See remarks and comments.

2. Common requirements for all bands

FCC PART 15 PARAGRAPH		VERDICT			
		NA	P	F	NM
15.407 (c)	Transmission in case of absence of information to transmit, or operational failure.				NM ²

2: See remarks and comments.

Appendix A – Test result for 5.725 GHz – 5.85 GHz band

INDEX

TEST CONDITIONS	11
99 % and 26 dB Bandwidth.....	15
Section 15.407 Subclause (e) / RSS-247 Clause 6.2.4.1. 6 dB bandwidth	22
Section 15.407 Subclause (a) (3) / RSS-247 Clause 6.4.2.1. Maximum output power, Maximum power spectral density and antenna gain	29
Section 15.407 Subclause (b) (4) / RSS-247 Clause 6.2.4.2. Undesirable radiated emissions (Transmitter) 1 to 40 GHz..	41

TEST CONDITIONS

Power supply (V):
 $V_{\text{nominal}} = 13.2 \text{ Vdc}$

Type of power supply = External power supply (Battery).
Type of antenna: External antenna.
Declared Gain for antenna WiFi 5 GHz (maximum) = -5.4 dBi.

Operating frequencies in the sub-band 5.725-5.85 GHz.

- For IEEE 802.11a, the equipment uses channels 149, 157, 165.
- For IEEE 802.11n, there are two bandwidths:
 - For 20 MHz bandwidth the equipment uses channels 149, 157, 165.
 - For 40 MHz bandwidth the equipment uses channels 151, 159.
- For IEEE 802.11ac, there are three bandwidths:
 - For 20 MHz bandwidth the equipment uses channels 149, 157, 165.
 - For 40 MHz bandwidth the equipment uses channels 151, 159.
 - For 80 MHz bandwidth the equipment uses channel 155.

TEST FREQUENCIES:

For WiFi a/n20/ac20:
Lowest channel (149): 5745 MHz
Middle channel (157): 5785 MHz
Highest channel (165): 5825 MHz
For WiFi n40/ac40:
Lowest channel (151): 5755 MHz
Highest channel (159): 5795 MHz
For WiFi ac80:
Middle channel (155): 5775 MHz

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.

The data rates of 6Mb/s for 802.11a, HT0 (SISO) for 802.11n20/ac20 and n40/ac40, and VHT0 (SISO) for 802.11ac80 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and spurious levels at the band edges.

The field strength at the band edges was evaluated for each mode and on each chain individually on the lowest and highest channels at the rated power for the channel under test. Where the power at the edge channels was lower than the power at the center channels additional measurements were made at the adjacent channels.

WIFI FCC:

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

a20 - Core0

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

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

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

n20 - Core0

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

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

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

n40 - Core0

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

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

ac80 - Core0

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

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is directly connected to the spectrum analyzer.



The DC supply voltage is applied using an external power supply which voltage is calibrated using a multimeter.

RADIATED MEASUREMENTS

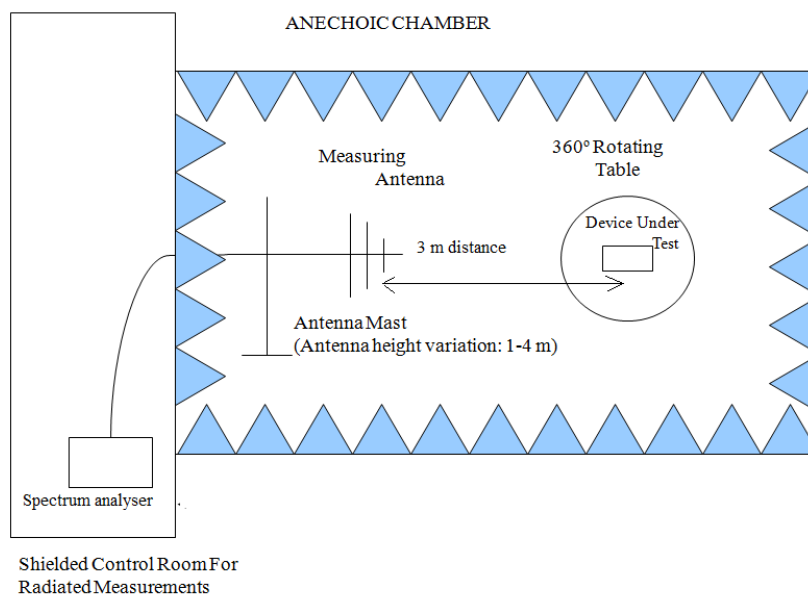
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 1m for the frequency range 1 GHz-40 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

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.

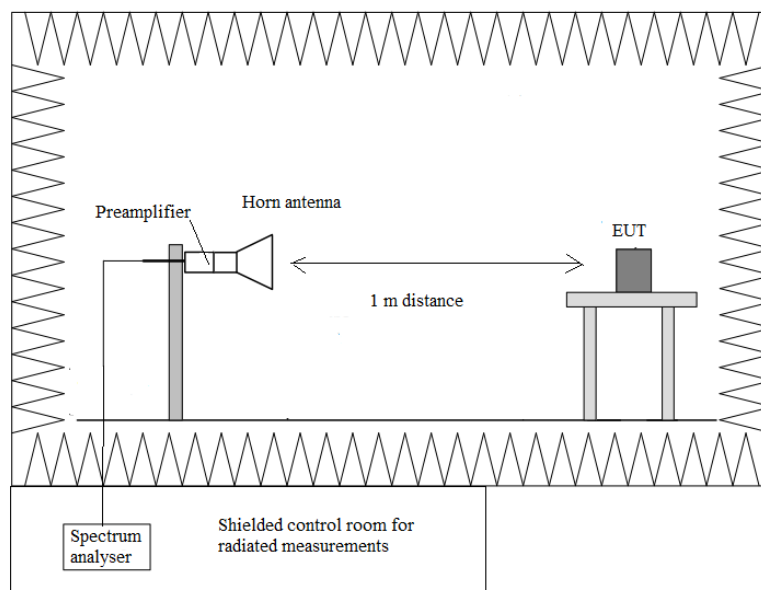
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360°.

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

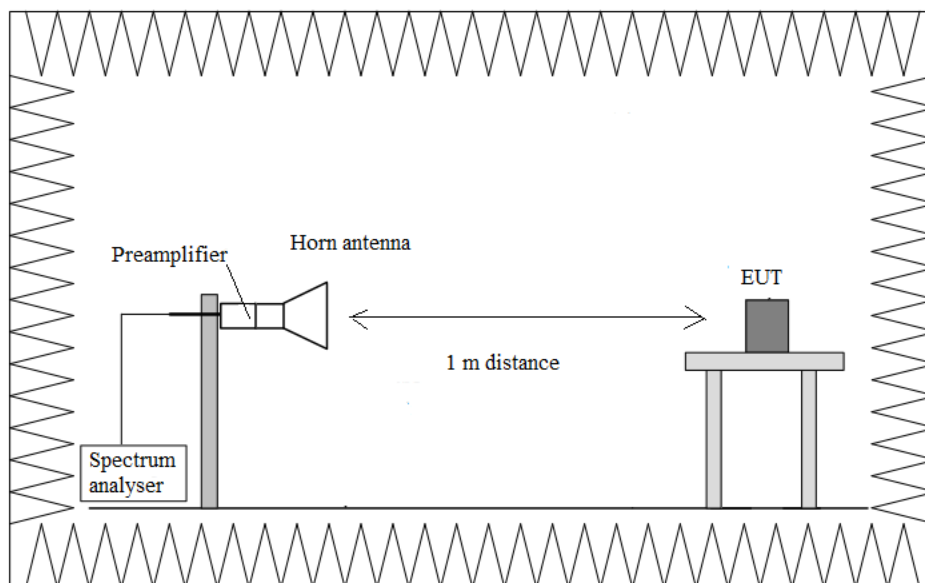
Radiated measurements setup $f < 1$ GHz.



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



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



99 % and 26 dB Bandwidth

RESULTS

1. 802.11a mode (see next plots).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
99% bandwidth (MHz)	17.120	17.080	17.200
26 dB bandwidth (MHz)	21.480	21.400	21.400
Measurement uncertainty (kHz)	<±23.02		

2. 802.11 n20 MHz and 802.11 ac 20 MHz modes. (see next plots).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
99% bandwidth (MHz)	18.440	18.440	18.520
26 dB bandwidth (MHz)	23.680	23.320	27.040
Measurement uncertainty (kHz)	<±23.02		

Note: the test was performed with 802.11 n20 MHz mode which is the same modulation scheme as 802.11 ac 20 MHz.

3. 802.11 n40 MHz and 802.11 ac 40 MHz modes. (see next plots).

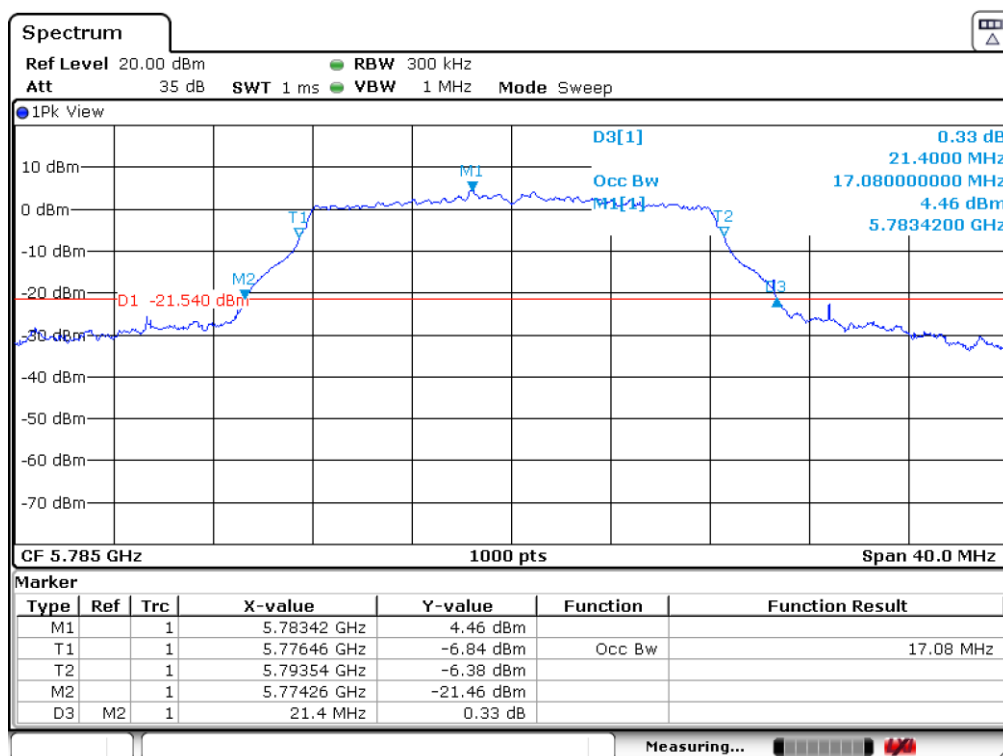
	Lowest frequency 5755 MHz	Highest frequency 5795 MHz
99% bandwidth (MHz)	36.700	36.700
26 dB bandwidth (MHz)	50.900	49.100
Measurement uncertainty (kHz)	<±55.05	

Note: the test was performed with 802.11 n40 MHz mode which is the same modulation scheme as 802.11 ac 40 MHz.

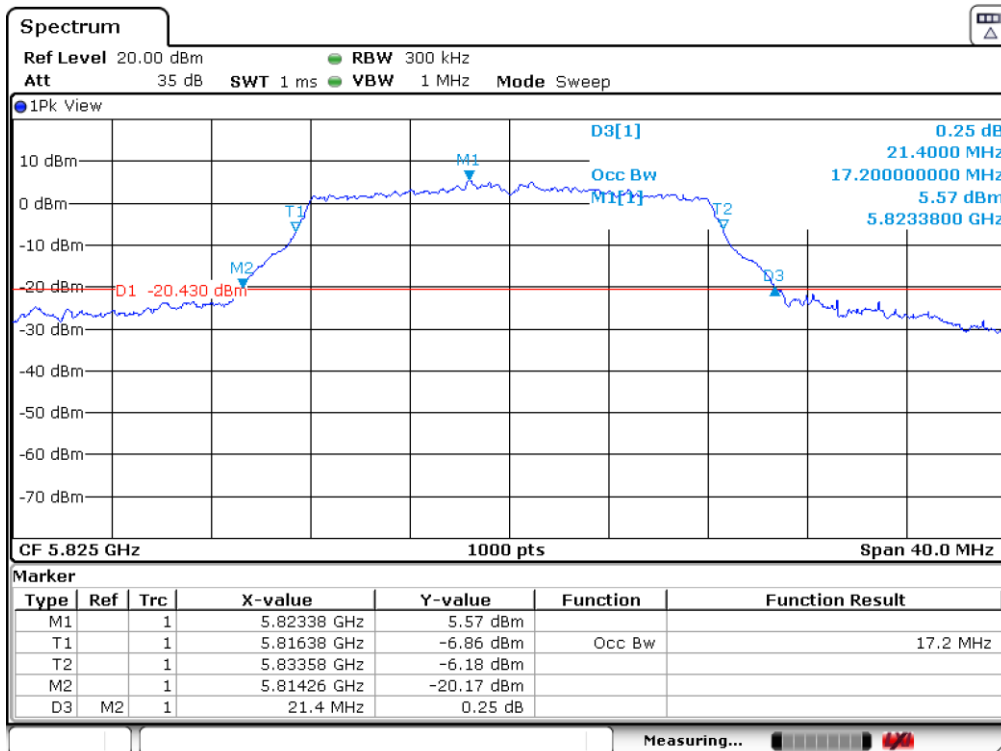
4. 802.11 ac 80 MHz mode. (see next plots).

	Frequency 5775 MHz
99% bandwidth (MHz)	76.08
26 dB bandwidth (MHz)	97.08
Measurement uncertainty (kHz)	<±70.07

Lowest Channel

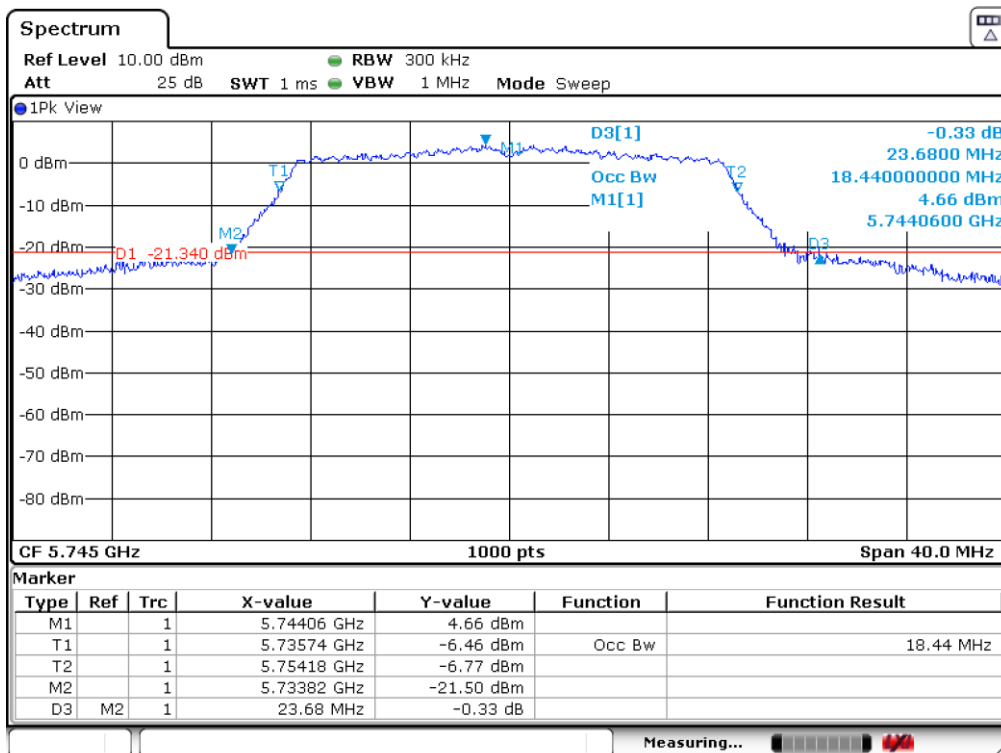


Highest Channel

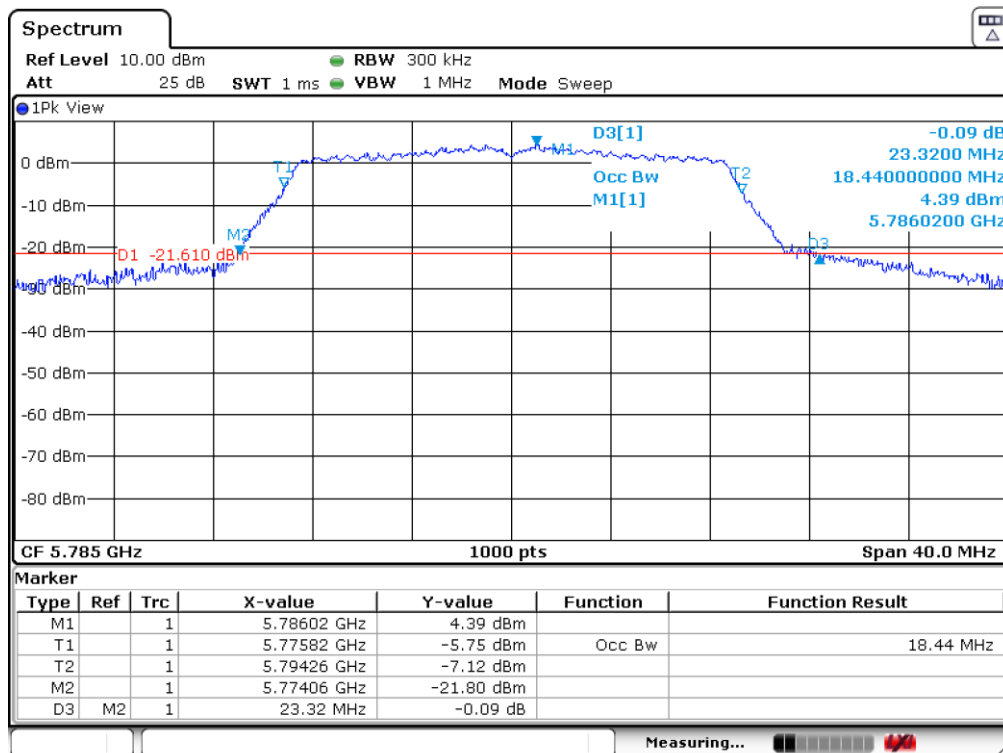


802.11 n20 MHz and 802.11 ac 20 MHz modes

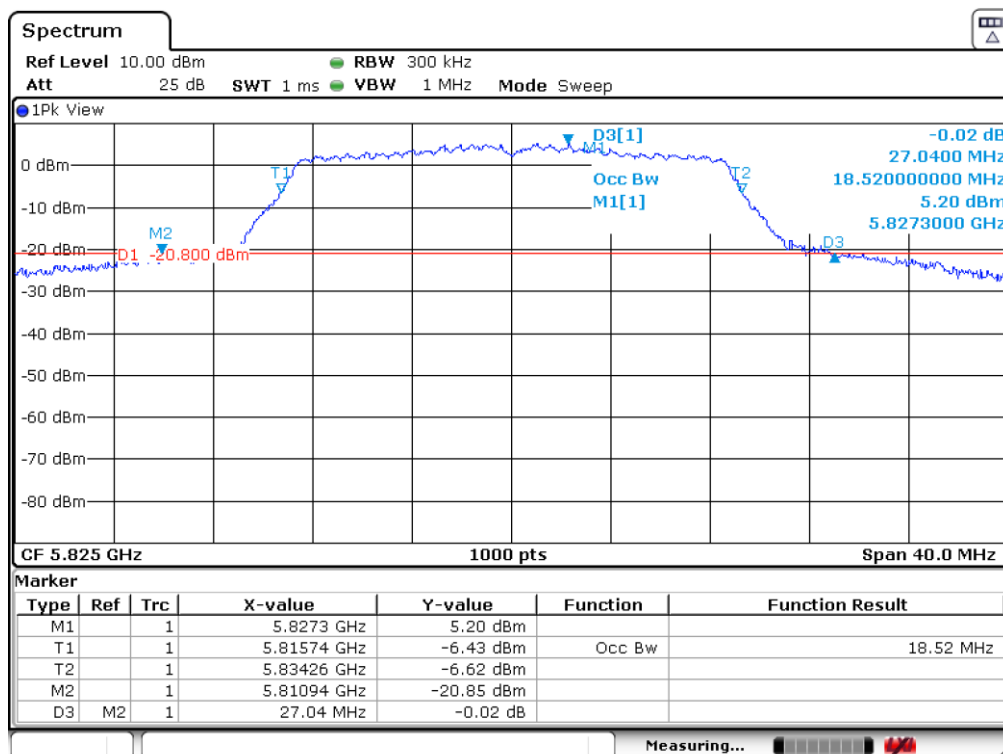
Lowest Channel



Middle Channel

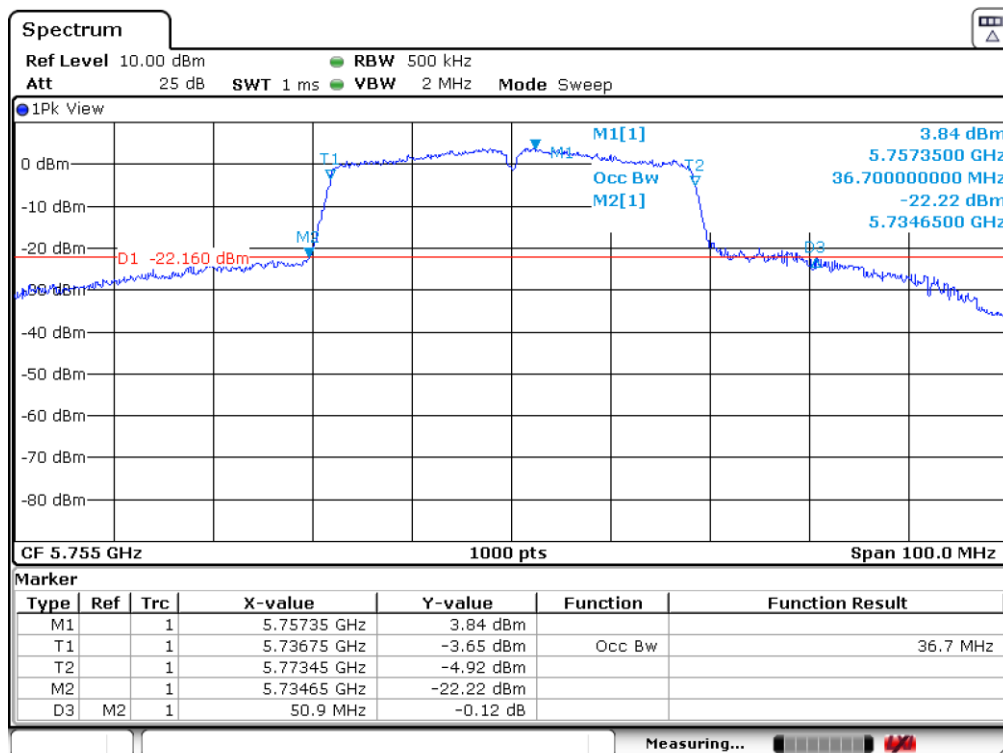


Highest Channel

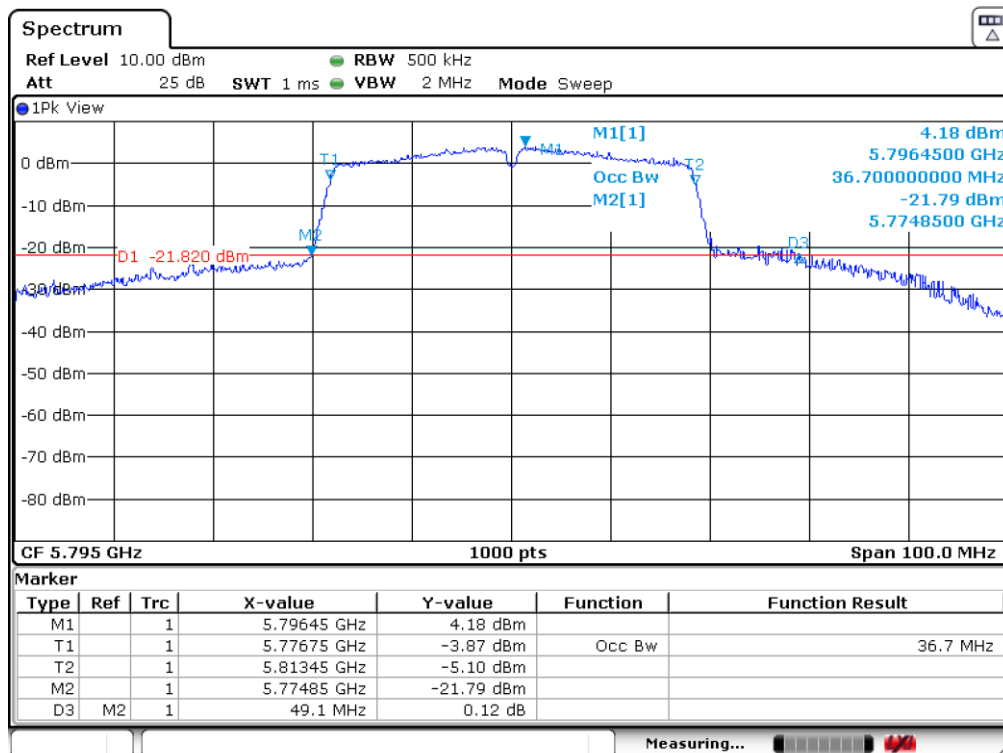


802.11 n40 MHz and 802.11 ac 40 MHz modes

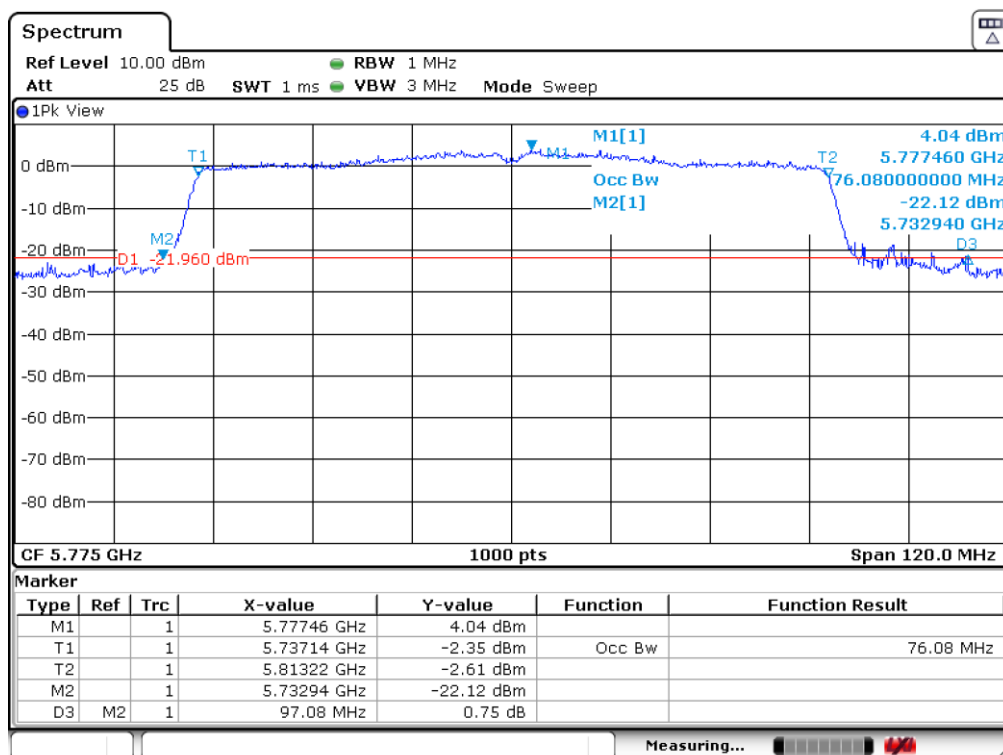
Lowest Channel



Highest Channel



802.11 ac 80 MHz mode



Section 15.407 Subclause (e) / RSS-247 Clause 6.2.4.1. 6 dB bandwidth

SPECIFICATION

FCC 15.407/RSS-247: Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

RESULTS

6 dB Bandwidth (see next plots).

1. 802.11a mode (see next plots).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
6 dB bandwidth (MHz)	16.300	16.300	16.300
Measurement uncertainty (kHz)	<±11.01		

2. 802.11 n20 MHz and 802.11 ac 20 MHz modes. (see next plots).

	Lowest frequency 5745 MHz	Middle frequency 5785 MHz	Highest frequency 5825 MHz
6 dB bandwidth (MHz)	17.540	17.540	17.580
Measurement uncertainty (kHz)	<±11.01		

Note: the test was performed with 802.11 n20 MHz mode which is the same modulation scheme as 802.11 ac 20 MHz.

3. 802.11 n40 MHz and 802.11 ac 40 MHz modes. (see next plots).

	Lowest frequency 5755 MHz	Highest frequency 5795 MHz
6 dB bandwidth (MHz)	35.800	35.650
Measurement uncertainty (kHz)	<±26.03	

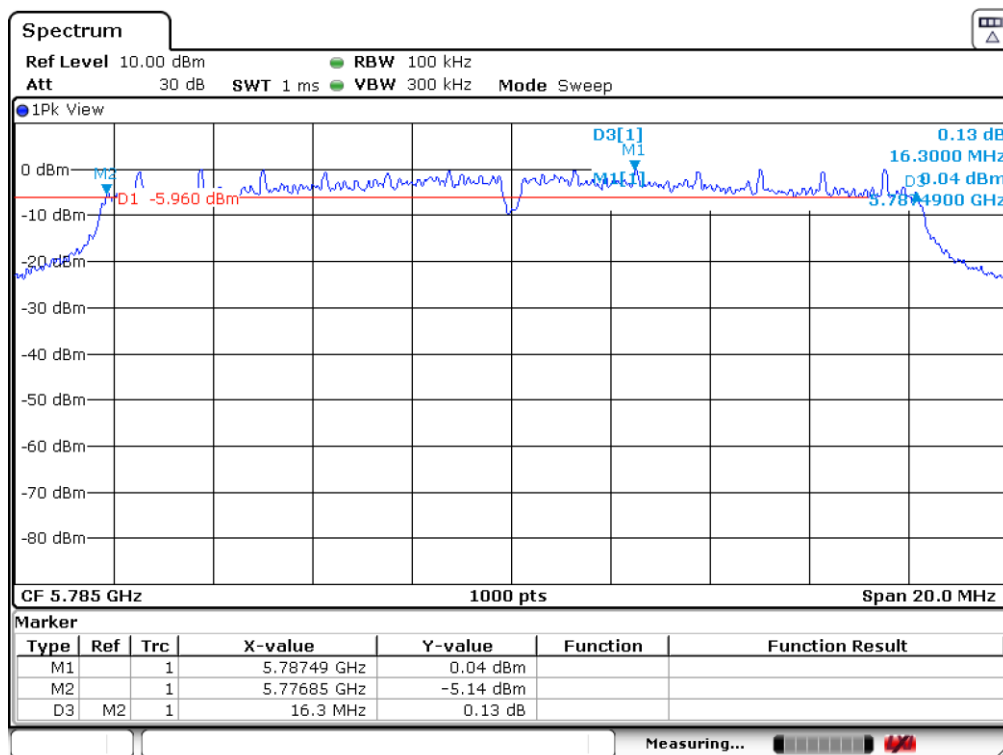
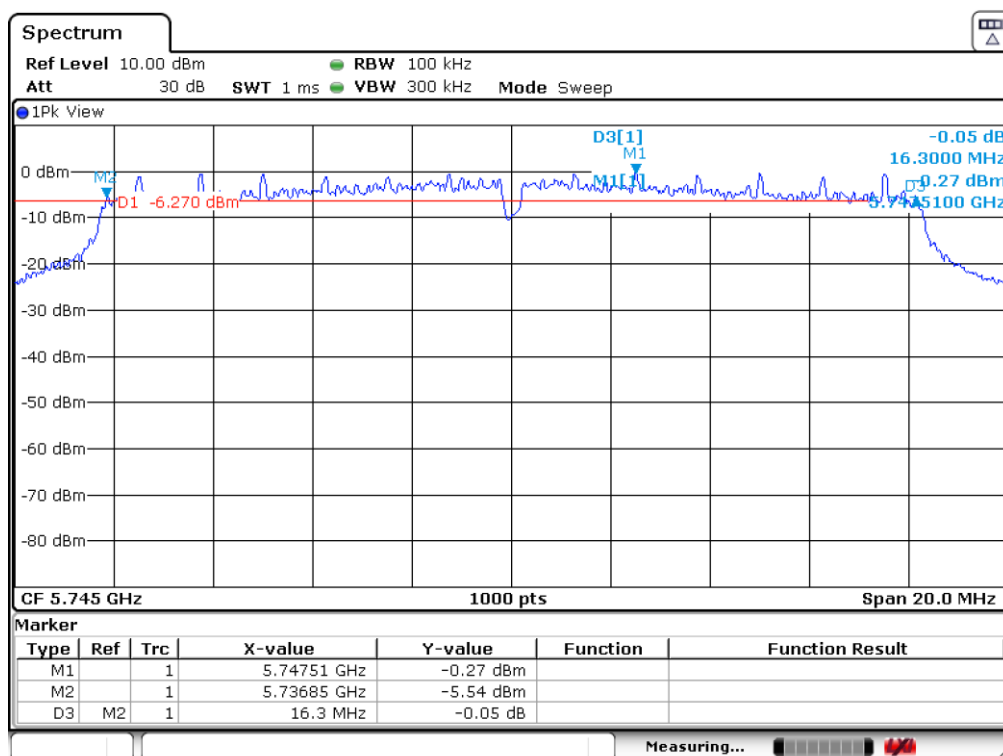
Note: the test was performed with 802.11 n40 MHz mode which is the same modulation scheme as 802.11 ac 40 MHz.

4. 802.11 ac 80 MHz mode. (see next plots).

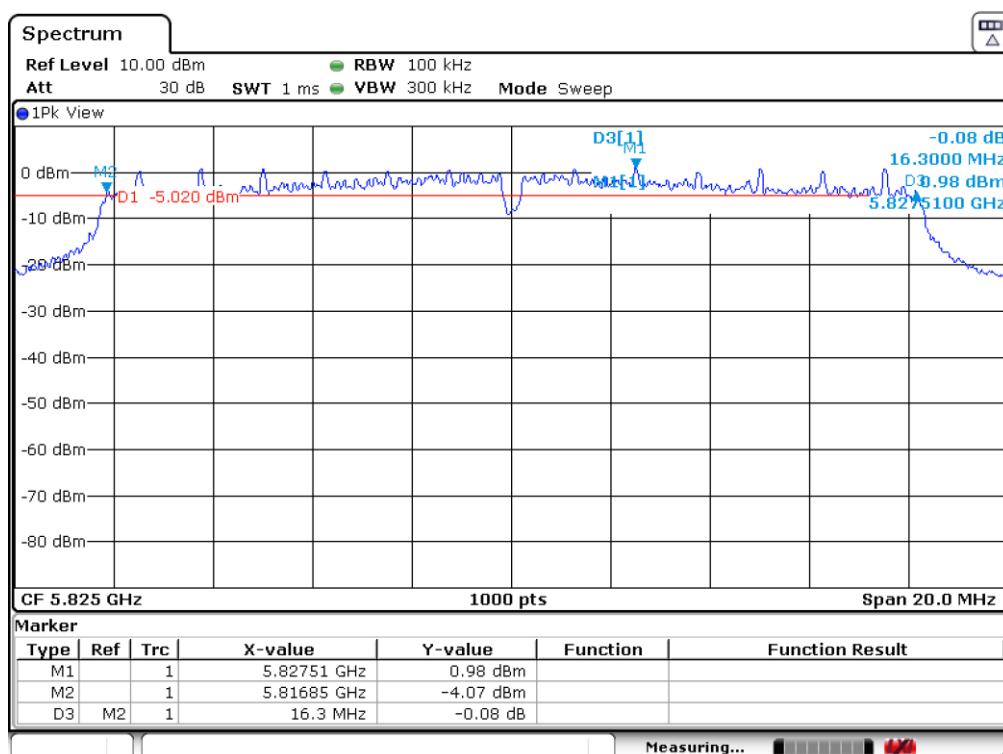
	Frequency 5775 MHz
6 dB bandwidth (MHz)	75.600
Measurement uncertainty (kHz)	<±61.07

Verdict: PASS

Lowest Channel

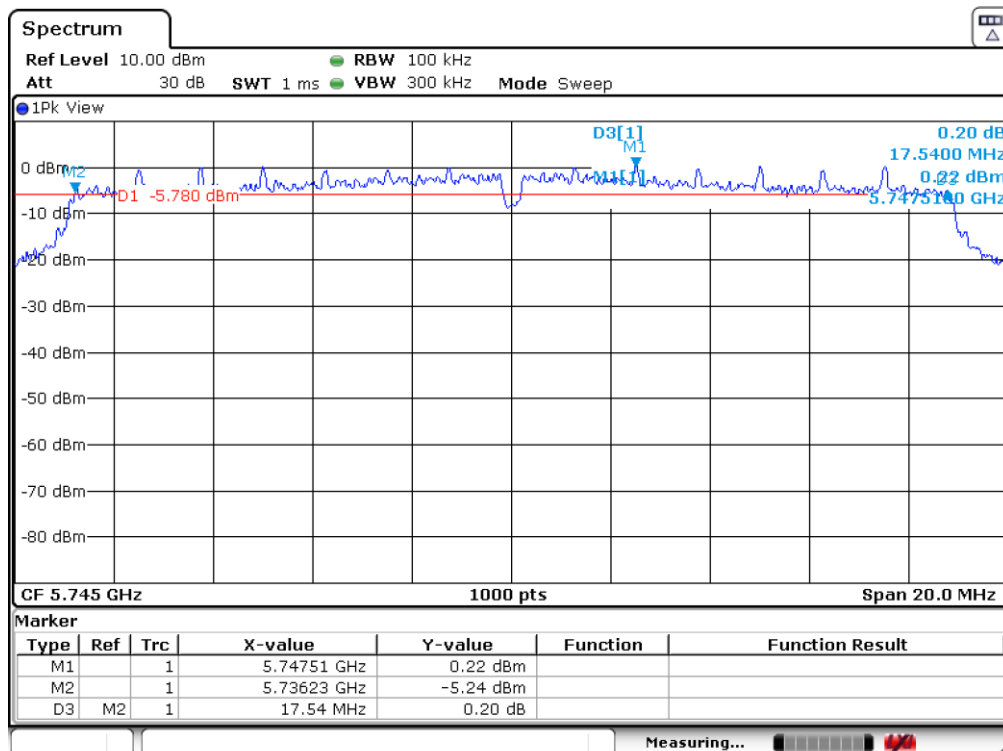


Highest Channel

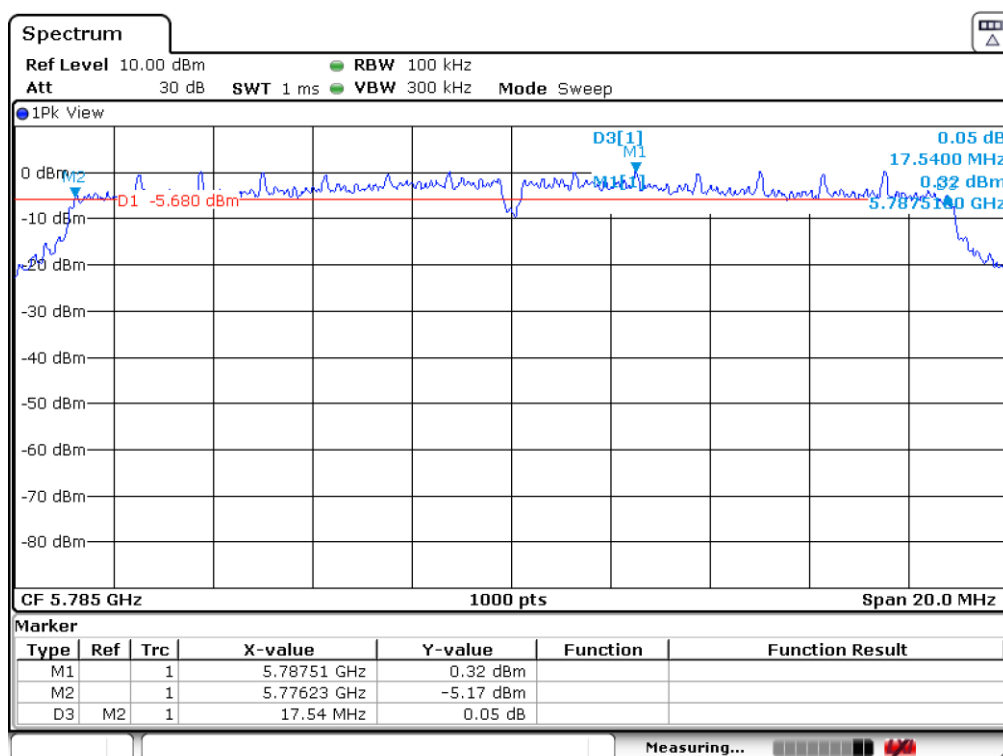


802.11 n20 MHz and 802.11 ac 20 MHz modes

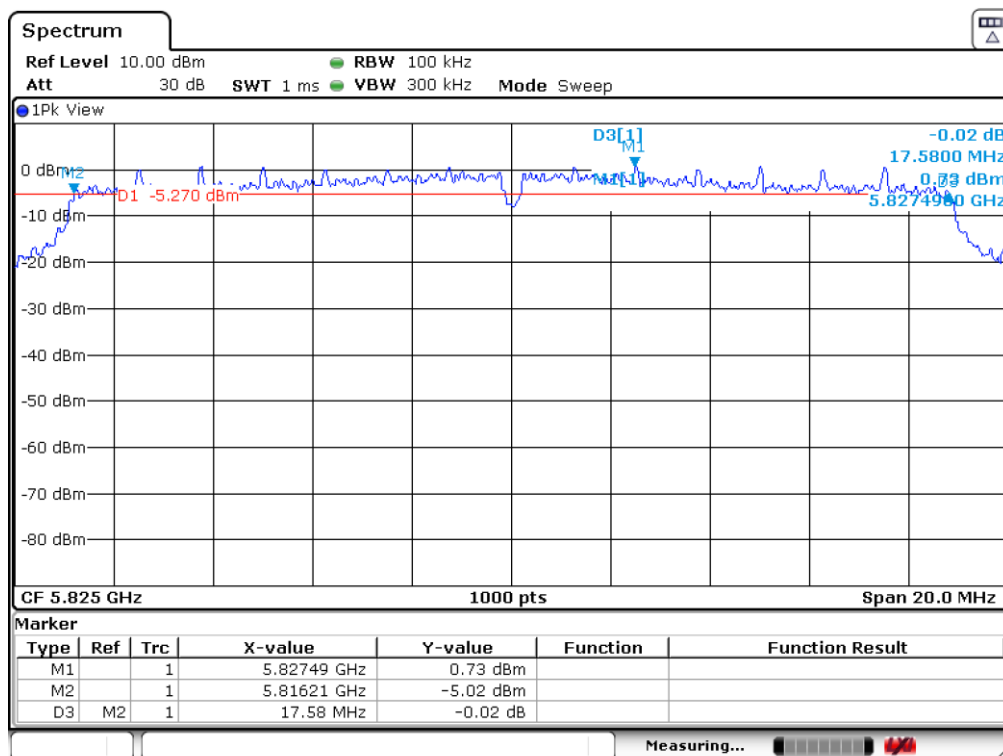
Lowest Channel



Middle Channel

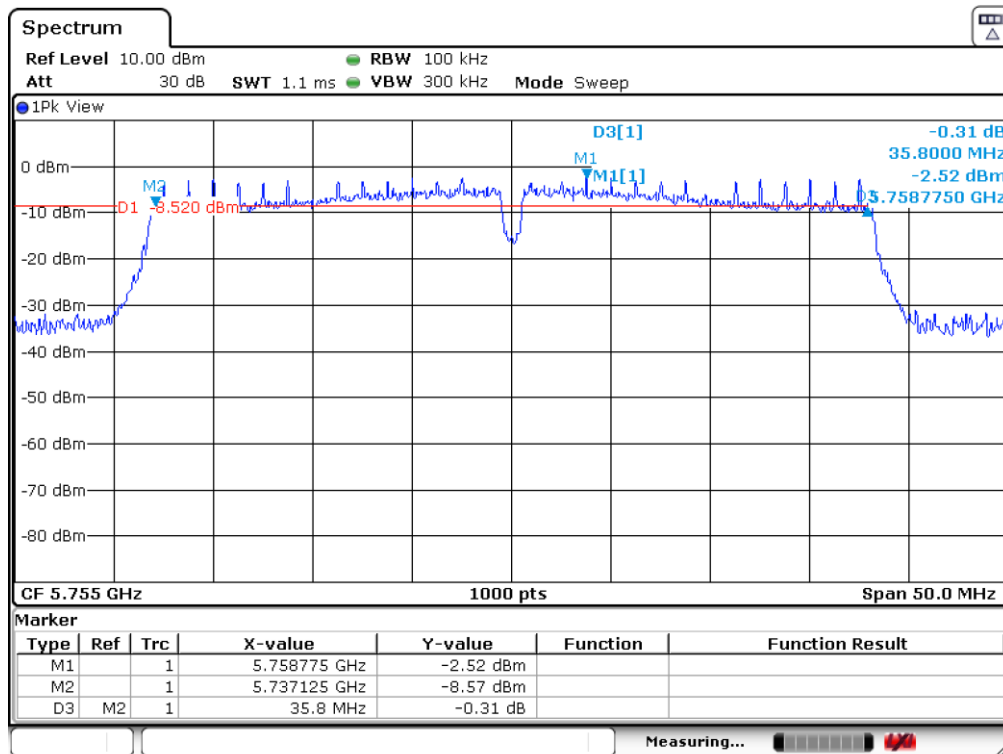


Highest Channel

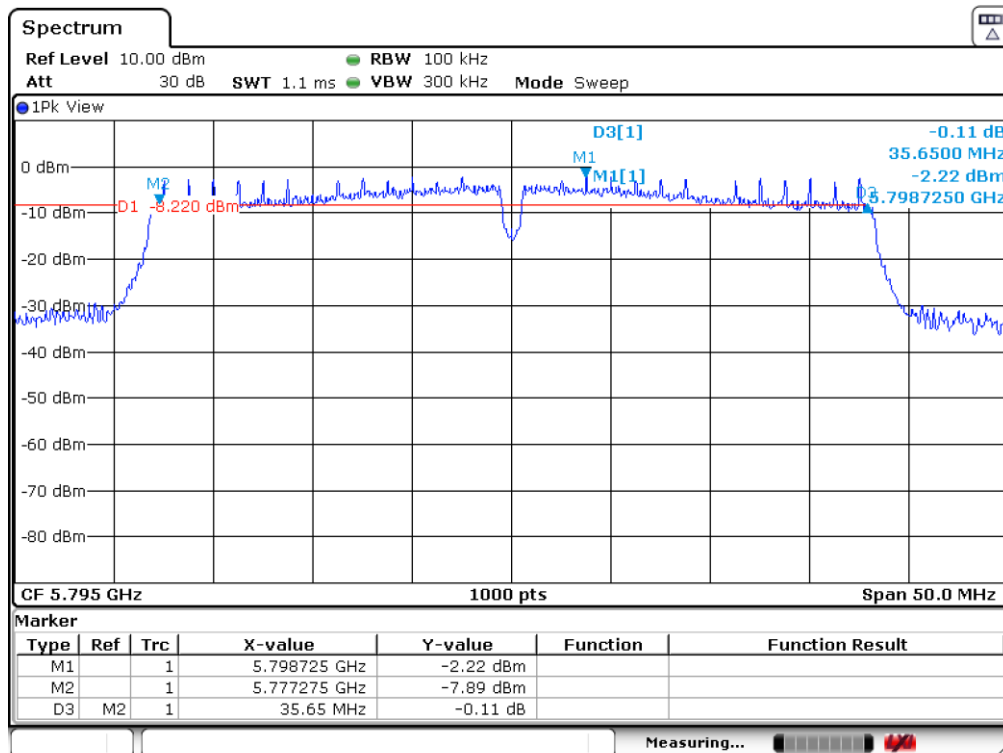


802.11 n40 MHz and 802.11 ac 40 MHz modes

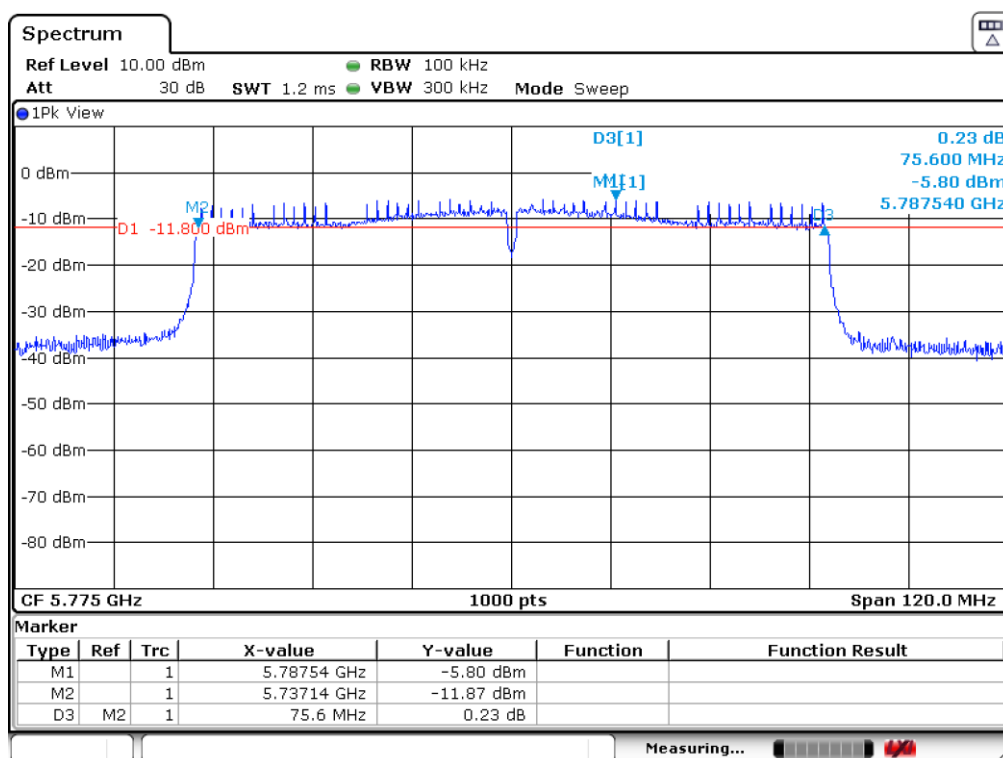
Lowest Channel



Highest Channel



802.11 ac 80 MHz mode



Section 15.407 Subclause (a) (3) / RSS-247 Clause 6.4.2.1. Maximum output power, Maximum power spectral density and antenna gain

SPECIFICATION

FCC 15.407/RSS-247: For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30 dBm). In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RESULTS

The maximum conducted output power was measured using the channel power integration method according to point E) 2) b) (Method SA-1) of Guidance 789033 D02 General UNII Test Procedures New Rules v02r01 dated 12/14/2017.

The e.i.r.p. levels are calculated by adding the declared maximum antenna gain (dBi).

The maximum power spectral density (PSD) was measured over 500 kHz.

1. 802.11a mode (see next plots).

Maximum declared antenna gain = -5.4 dBi

Frequency	Maximum conducted output power (dBm)	Maximum output power e.i.r.p. (dBm)	PSD/500 kHz (dBm)	PSD/500kHz e.i.r.p. (dBm)
5745 MHz	11.64	6.24	-0.56	-5.96
5785 MHz	11.83	6.43	-0.10	-5.50
5825 MHz	12.47	7.07	0.38	-5.02

Measurement uncertainty = $\leq \pm 1.20$ dB

Verdict: PASS

2. 802.11 n20 MHz and 802.11 ac 20 MHz modes. (see next plots).

Note: the test was performed with 802.11 n20 MHz mode which is the same modulation scheme as 802.11 ac 20 MHz.

Maximum declared antenna gain = -5.4 dBi

Frequency	Maximum conducted output power (dBm)	Maximum output power e.i.r.p. (dBm)	PSD/500kHz (dBm)	PSD/500kHz e.i.r.p. (dBm)
5745 MHz	11.63	6.23	-1.97	-7.37
5785 MHz	11.87	6.47	-1.58	-6.98
5825 MHz	12.46	7.06	-1.20	-6.60

Measurement uncertainty = $\leq \pm 1.20$ dB

Verdict: PASS

3. 802.11 n40 MHz and 802.11 ac 40 MHz modes. (see next plots).

Note: the test was performed with 802.11 n40 MHz mode which is the same modulation scheme as 802.11 ac 40 MHz.

Maximum declared antenna gain = -5.4 dBi

Frequency	Maximum conducted output power (dBm)	Maximum output power e.i.r.p. (dBm)	PSD/500kHz (dBm)	PSD/500kHz e.i.r.p. (dBm)
5755 MHz	11.58	6.18	-4.54	-4.41
5795 MHz	11.99	6.59	-9.94	-9.81

Measurement uncertainty = $\leq \pm 1.20$ dB

Verdict: PASS

4. 802.11 ac 80 MHz mode. (see next plots).

Maximum declared antenna gain = -5.4 dBi

Frequency	Maximum conducted output power (dBm)	Maximum output power e.i.r.p. (dBm)	PSD/500kHz (dBm)	PSD/500kHz e.i.r.p. (dBm)
5775 MHz	11.23	5.83	-7.89	-13.29

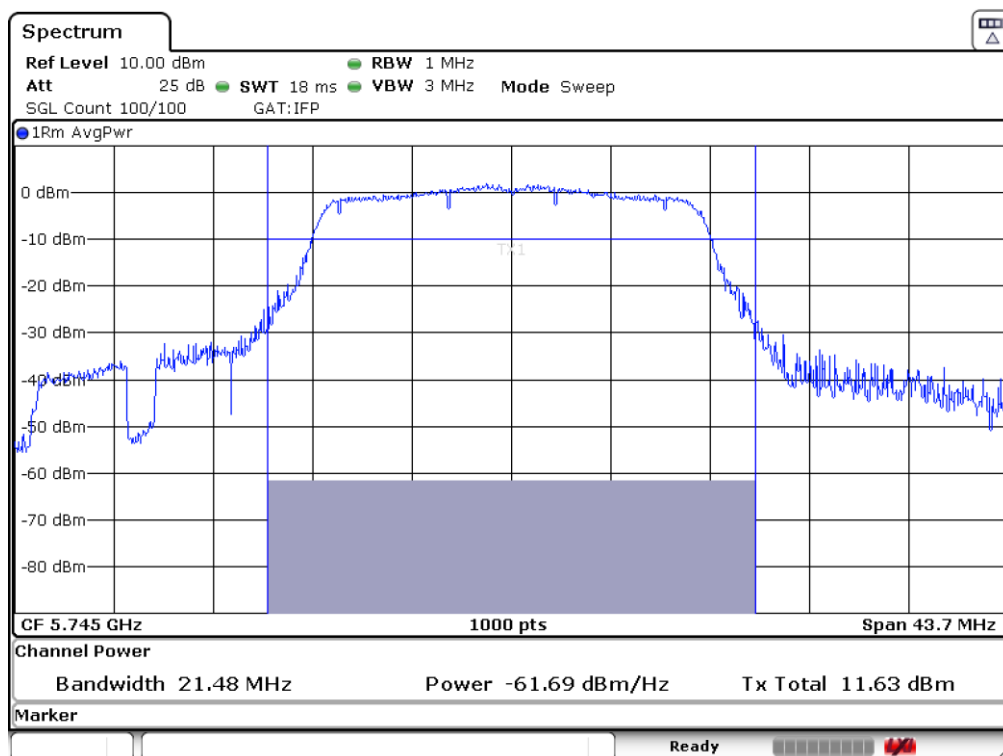
Measurement uncertainty = $\leq \pm 1.20$ dB

Verdict: PASS

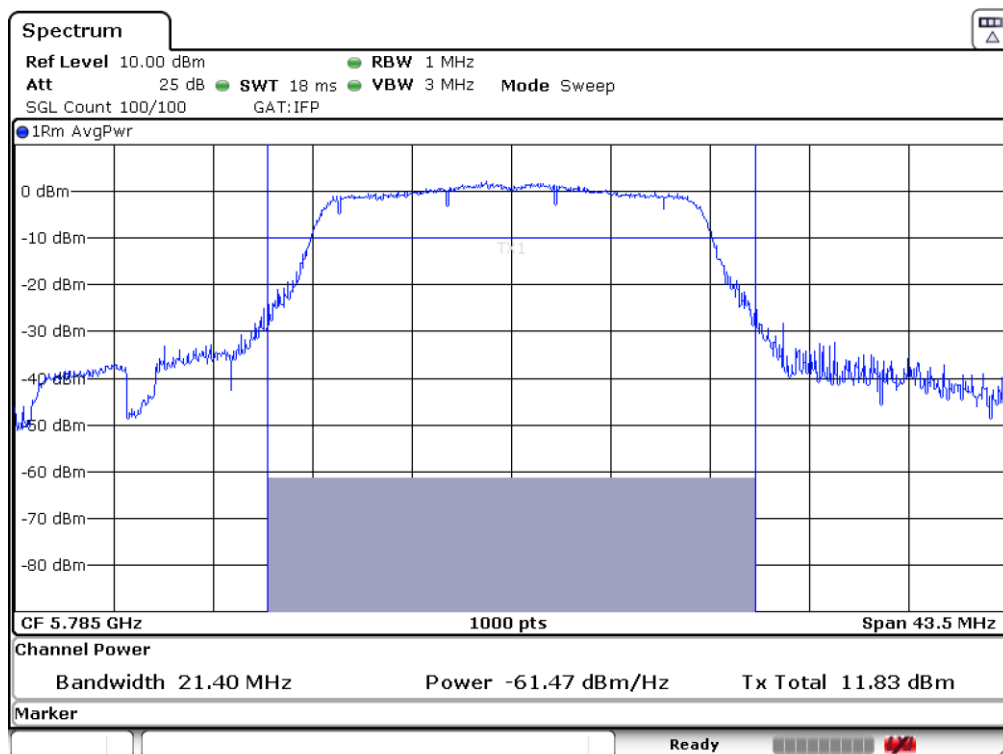
MAXIMUM OUTPUT POWER

802.11a mode

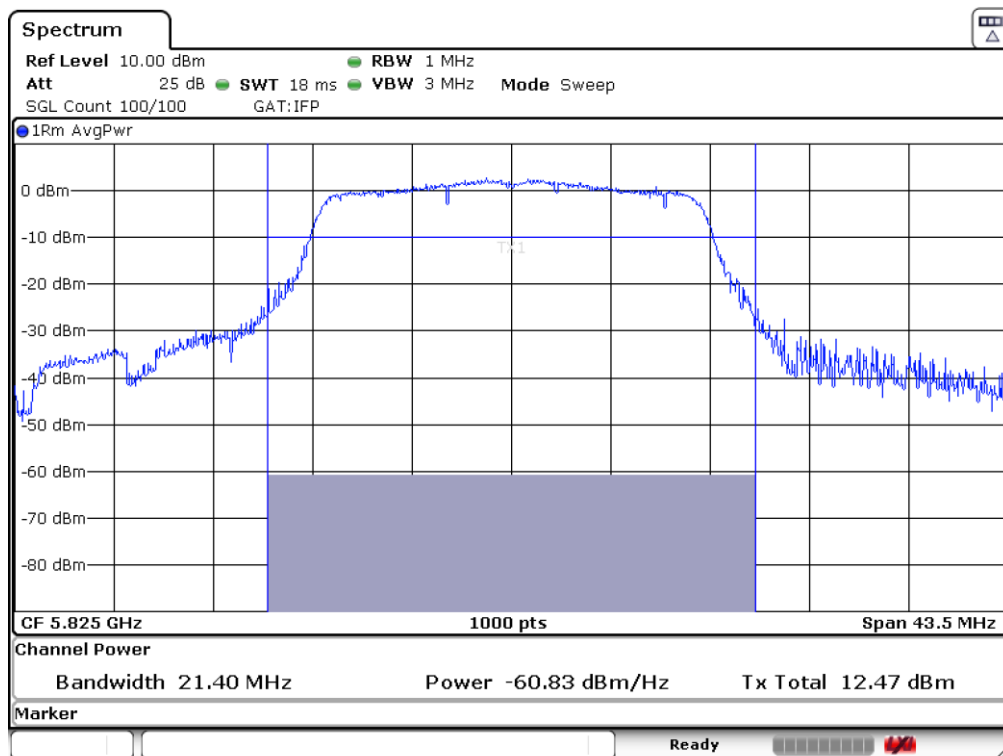
Lowest Channel



Middle Channel

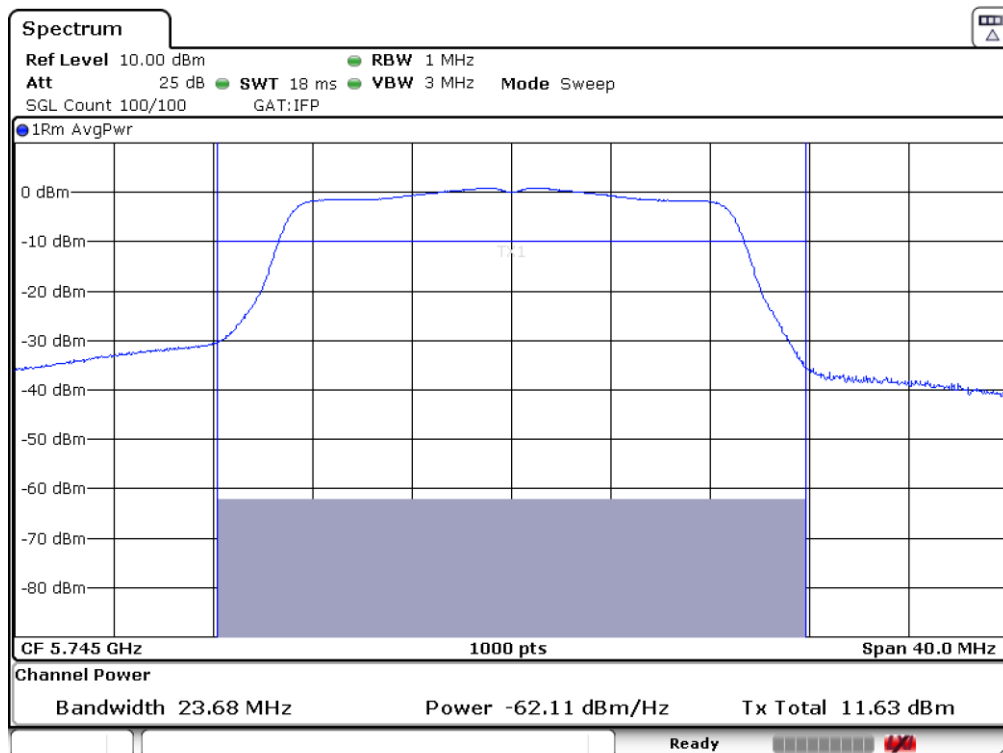


Highest Channel

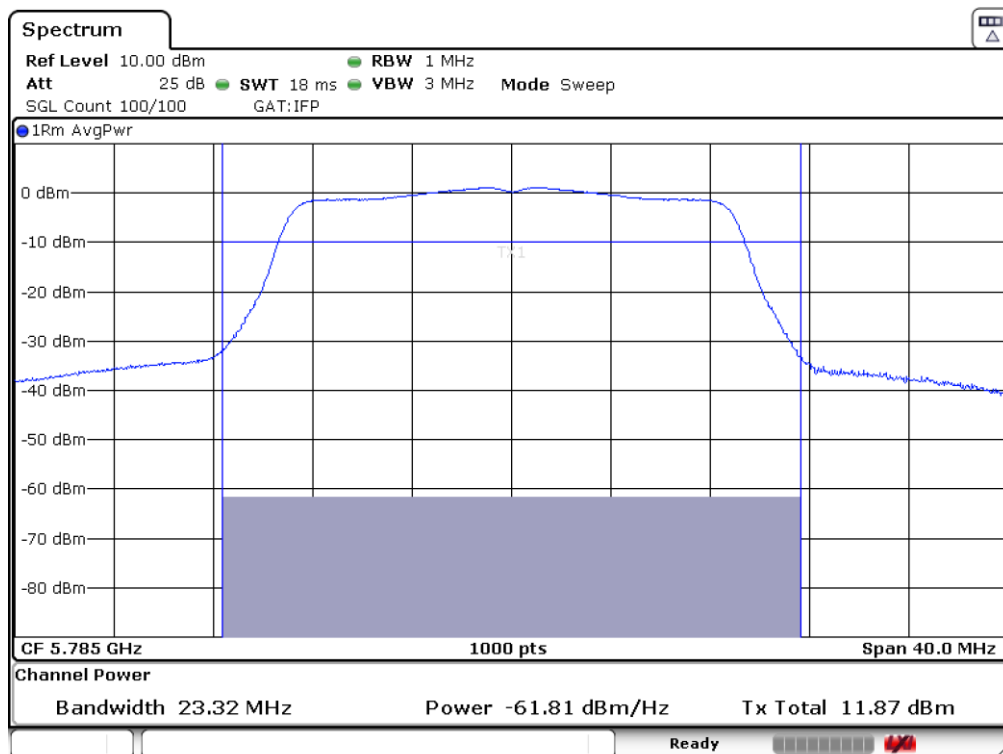


802.11 n20 MHz and 802.11 ac 20 MHz modes

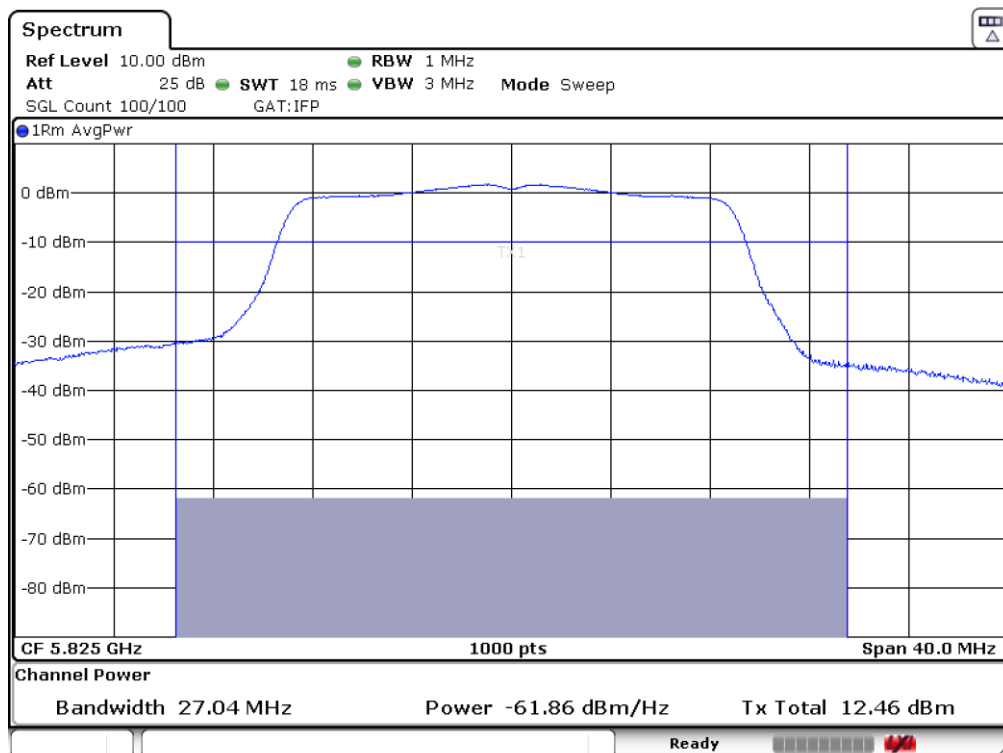
Lowest Channel



Middle Channel

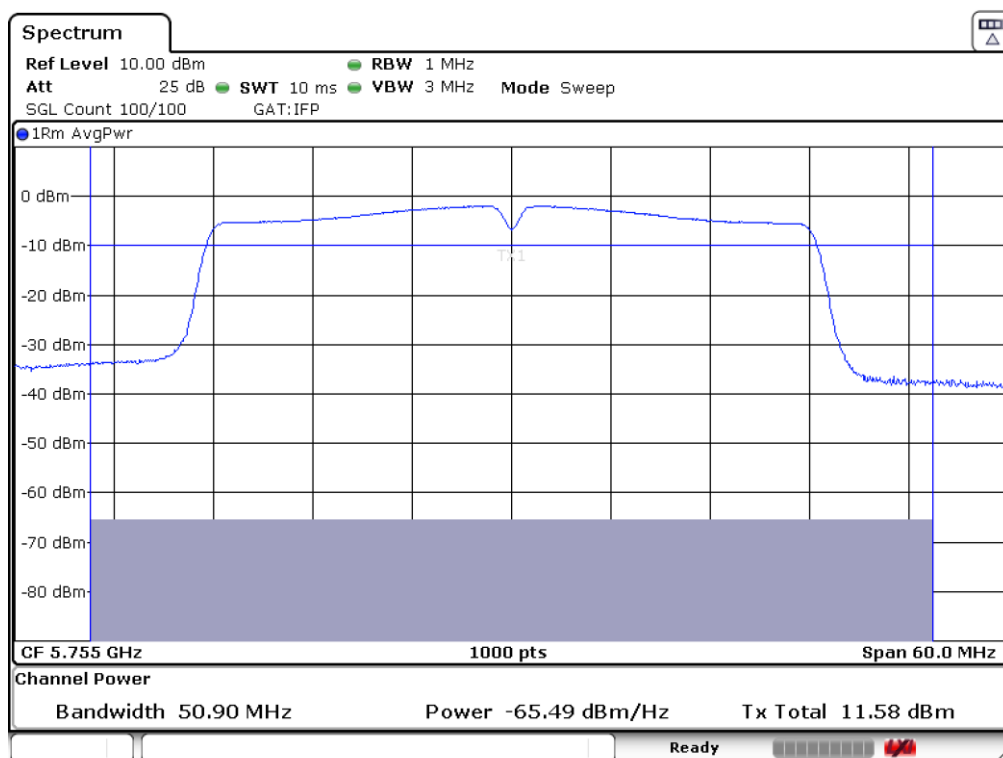


Highest Channel

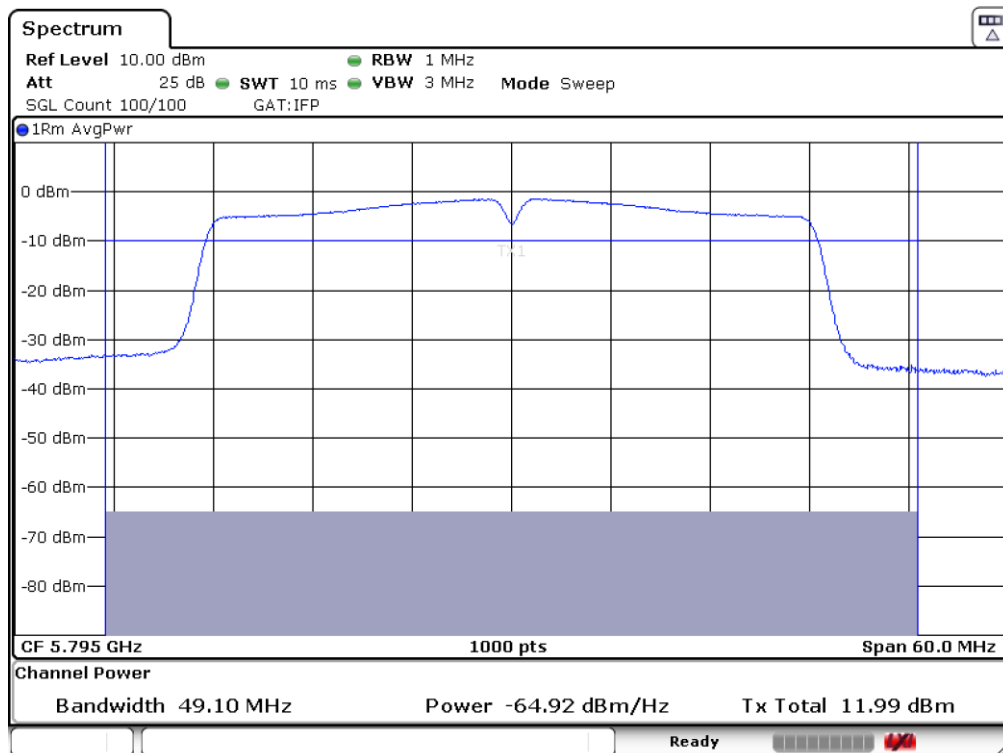


802.11 n40 MHz and 802.11 ac 40 MHz modes

Lowest Channel

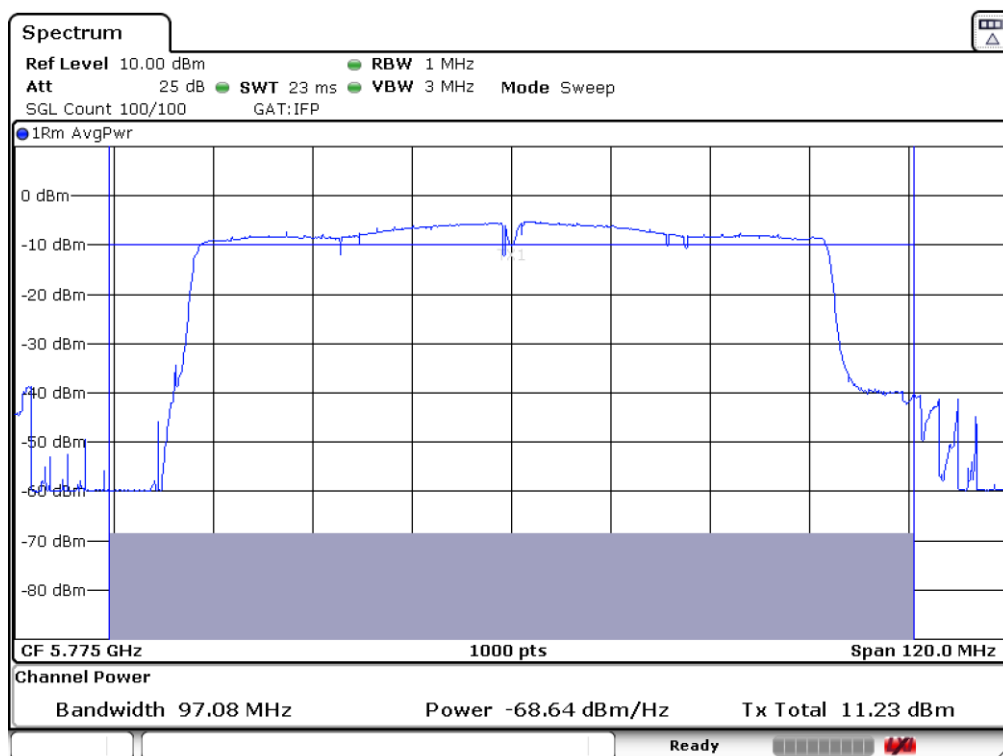


Highest Channel



802.11 ac 80 MHz mode

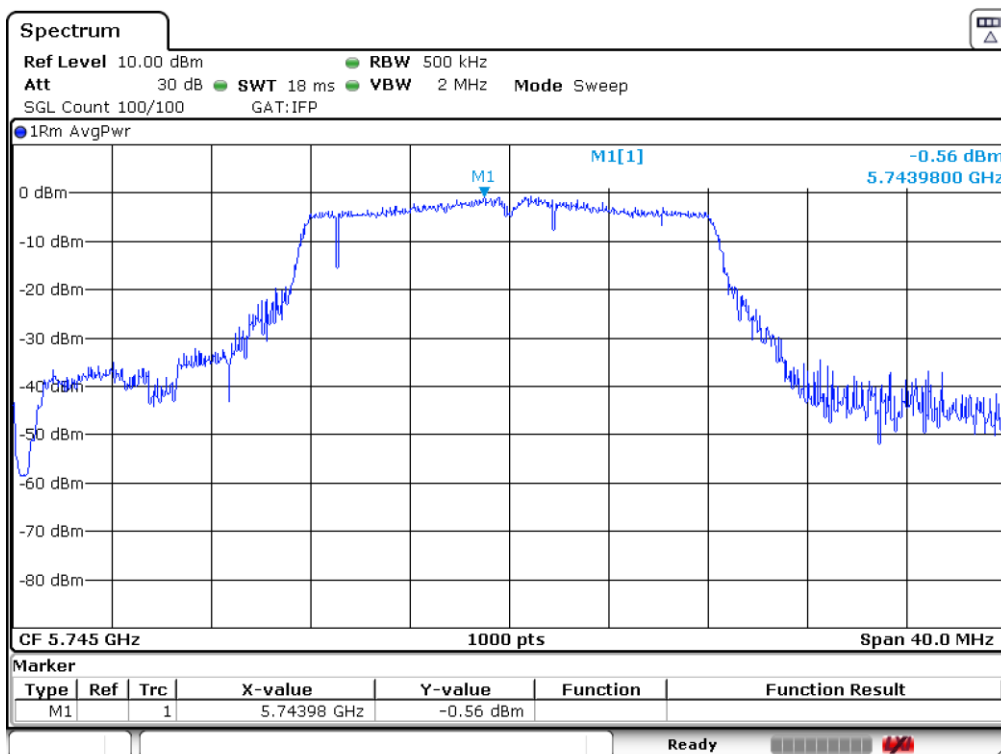
Middle Channel



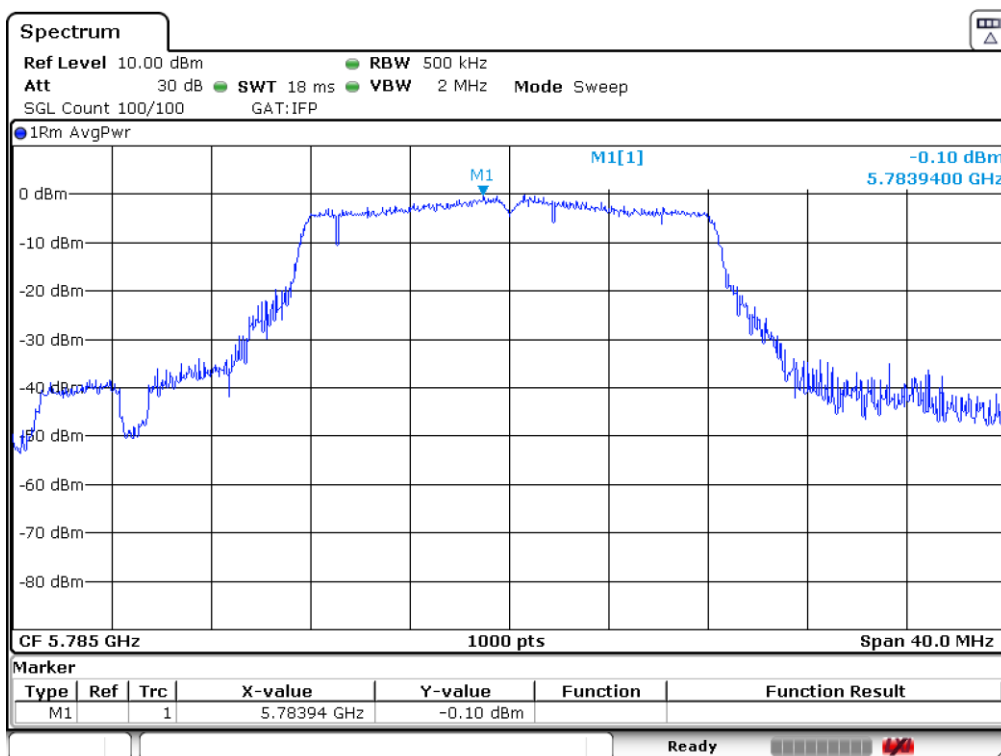
MAXIMUM POWER SPECTRAL DENSITY over 500 kHz

802.11a mode.

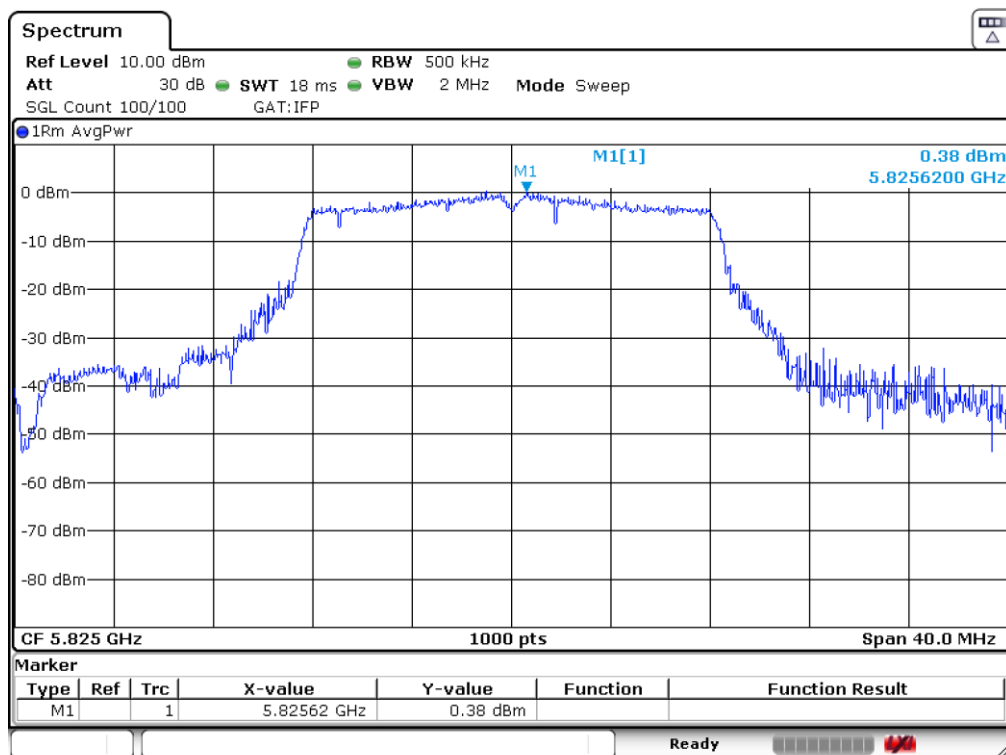
Lowest Channel



Middle Channel

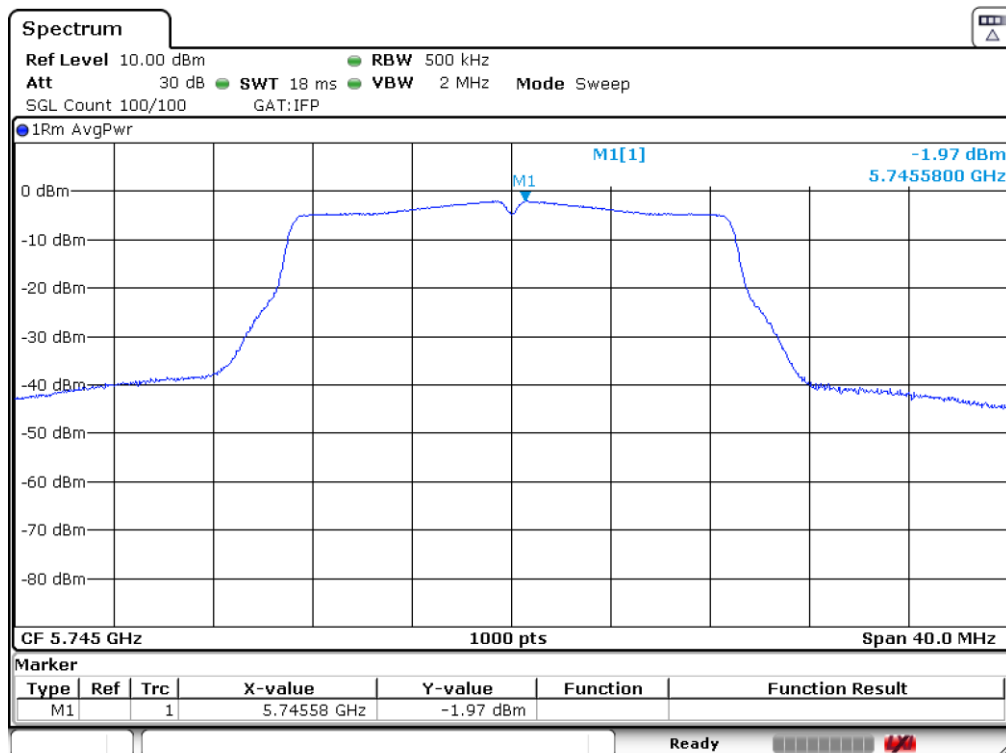


Highest Channel

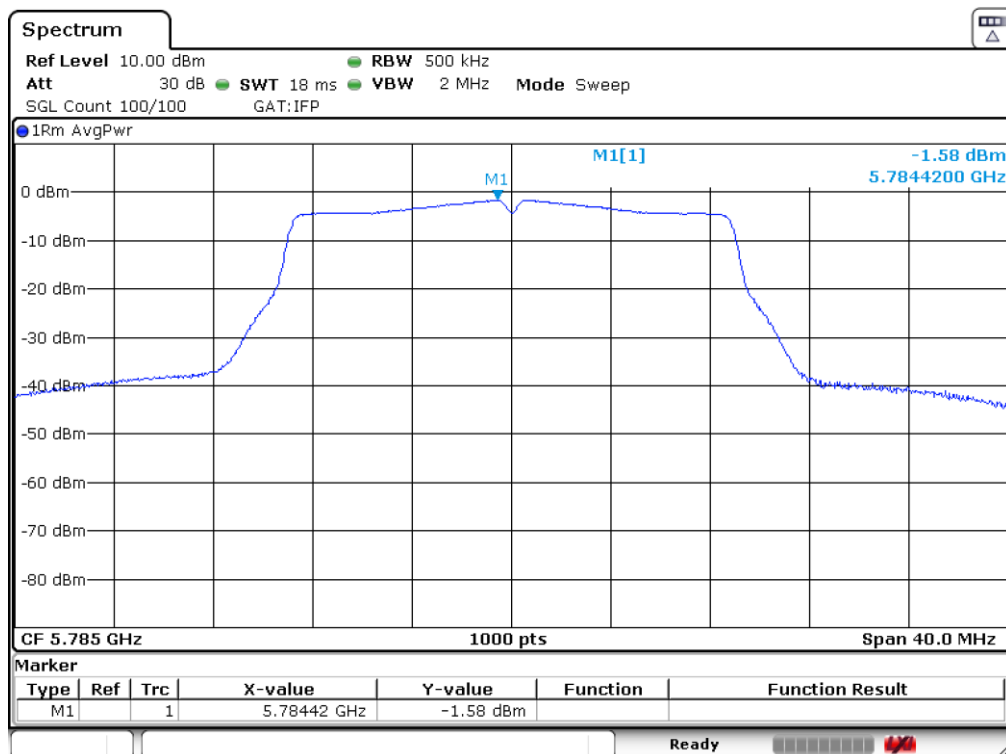


802.11 n20 MHz and 802.11 ac 20 MHz modes

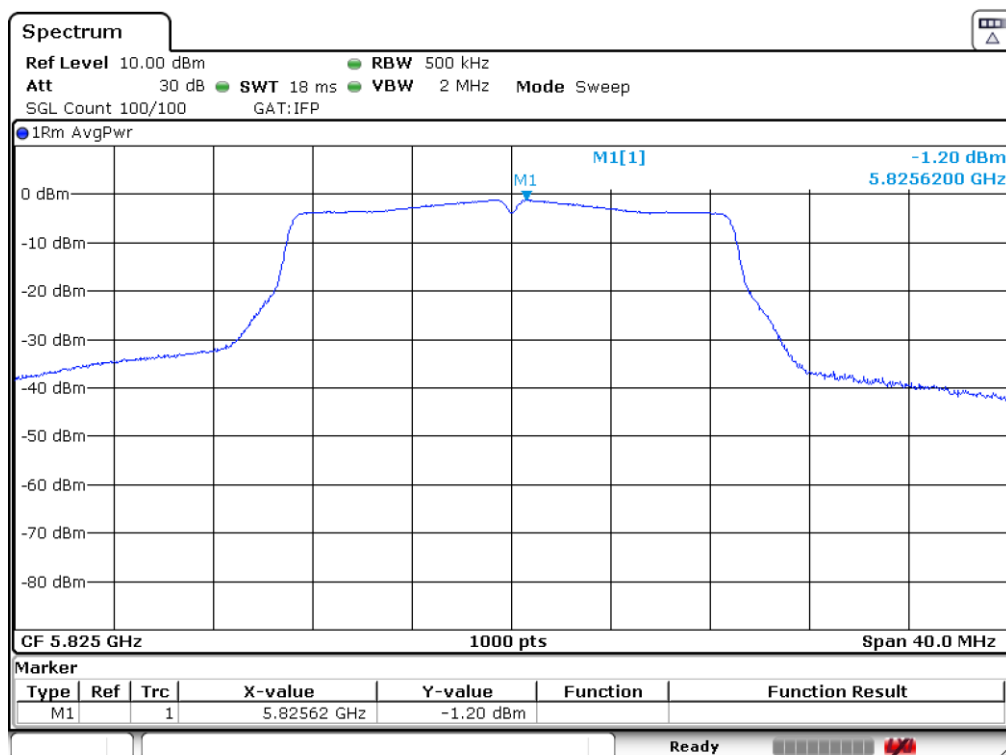
Lowest Channel



Middle Channel

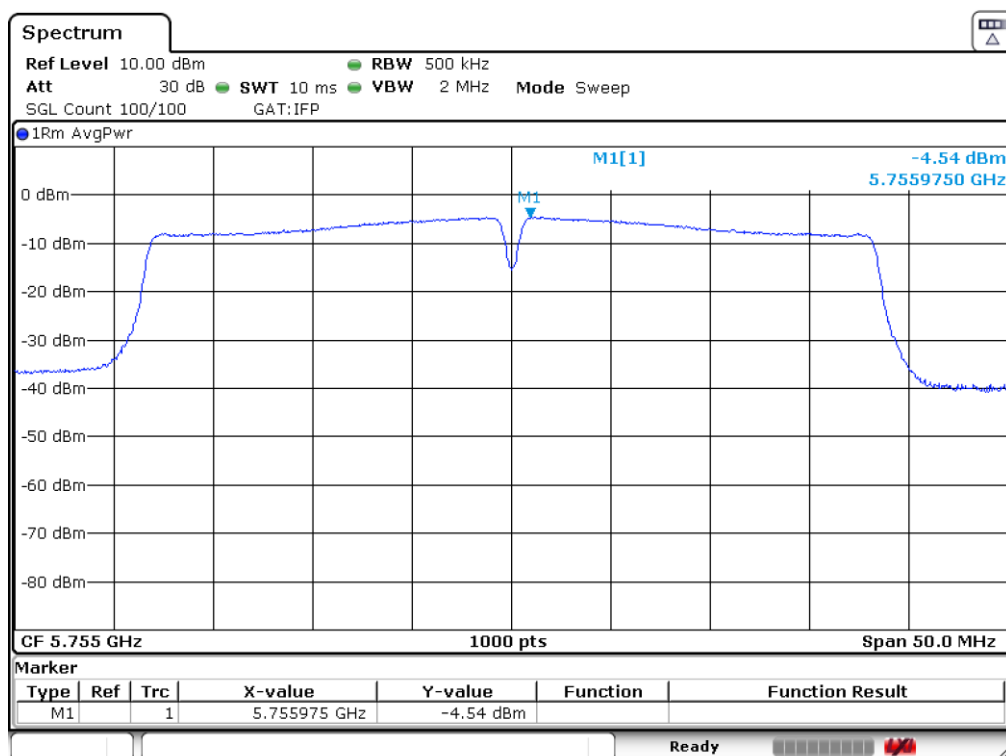


Highest Channel

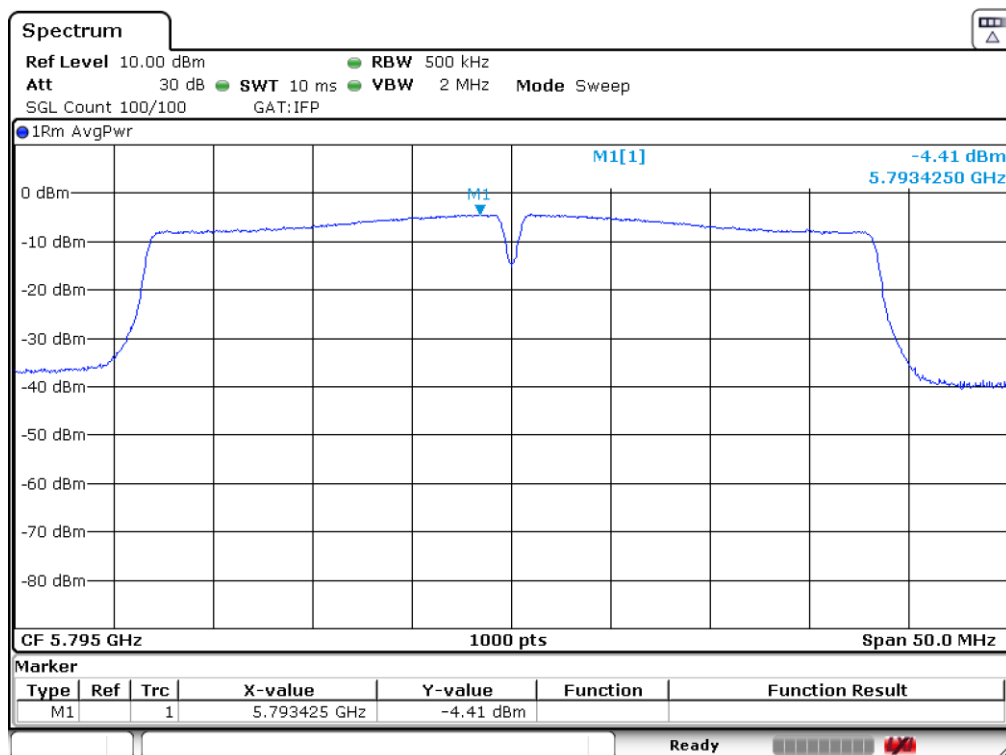


802.11 n40 MHz and 802.11 ac 40 MHz modes

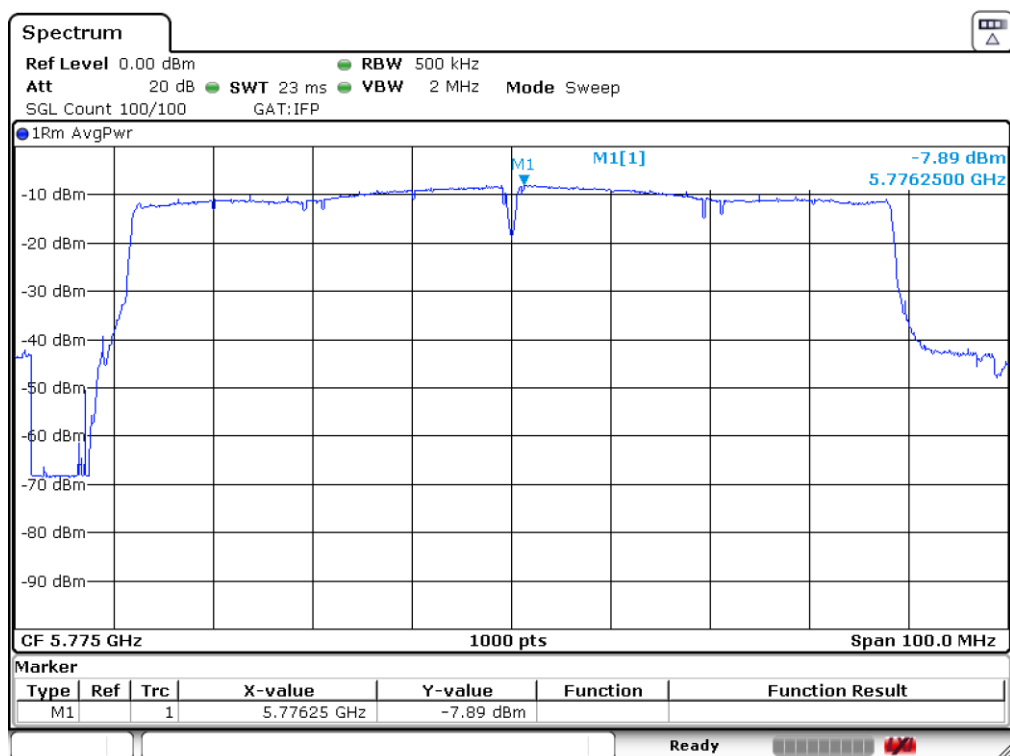
Lowest Channel



Highest Channel



802.11 ac 80 MHz mode



Section 15.407 Subclause (b) (4) / RSS-247 Clause 6.2.4.2. Undesirable radiated emissions (Transmitter) 1 to 40 GHz

SPECIFICATION

For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of -27 dBm/MHz (68.23 dB μ V/m at 3 m distance) at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength (μ V/m)	Field strength (dB μ V/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 40000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° to find the maximum radiated emission.

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

All tests were performed in a semi-anechoic chamber at a distance of 1m for the frequency range 1 GHz-40 GHz.

The test was performed with the equipment transmitting first with only the WiFi 5 GHz (WLAN0 CORE0) radio and repeated with the 2.4 GHz BT-EDR (WLAN 0), WiFi 2.4GHz (WLAN0 CORE1) radios transmitting simultaneously to check the impact of the co-location of the other radio interfaces. The results and plots below show the worst results obtained.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz-1 GHz

The spurious signals detected do not depend on either the operating channel or the modulation mode.

Spurious levels closest to limit:

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
759.546	V	Quasi-Peak	26.90	± 3.88

Frequency range 1 GHz-40 GHz

The results in the next tables show the maximum measured levels in the 1-40 GHz range including the 5.650-5.725 GHz and 5.85-5.925 GHz adjacent bands (see next plots).

For emissions out of the band 5.65 GHz-5.925 GHz, only the OFDM worst case mode determined after preliminary measurements was measured.

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

Spurious signals with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with an average detector for checking compliance with the average limit.

1. WiFi 5GHz 802.11 a mode

Lowest frequency 5745 MHz. Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Middle frequency 5785 MHz. Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Highest frequency 5825 MHz. Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Verdict: PASS

2. WiFi 5GHz 802.11 n20 mode.

Lowest frequency 5745 MHz. Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Middle frequency 5785 MHz. Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Highest frequency 5825 MHz. Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Verdict: PASS

3. WiFi 5GHz 802.11 n40 mode (OFDM worst case).

Lowest frequency 5755 MHz.

Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Spurious emissions outside band 5.65-5.925 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
11.50615	V	Peak	55.63	± 4.87
		Average	46.45	± 4.87

Highest frequency 5795 MHz.

Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Spurious emissions outside band 5.65-5.925 GHz.

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
11.58278	H	Peak	58.37	± 4.87
		Average	49.43	± 4.87

Verdict: PASS

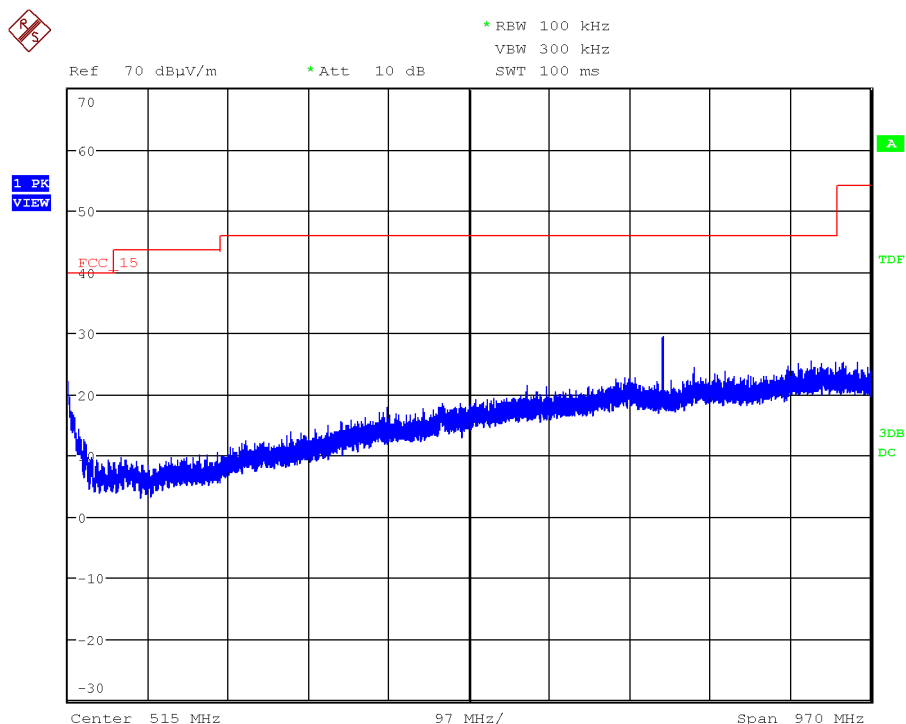
4. WiFi 5GHz 802.11 ac80 mode

Middle frequency 5775 MHz. Spurious emissions inside band 5.65-5.925 GHz.

No radiated spurious signals were detected for the operating channel.

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

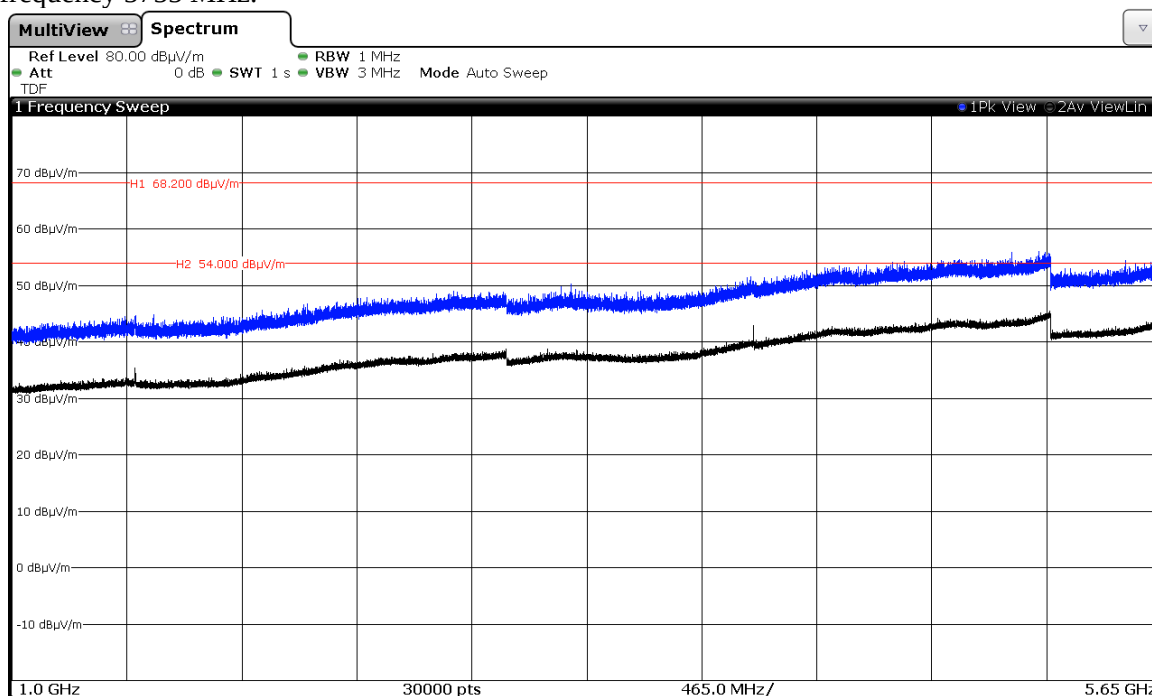


(This plot is valid for all channels and all modulation modes).

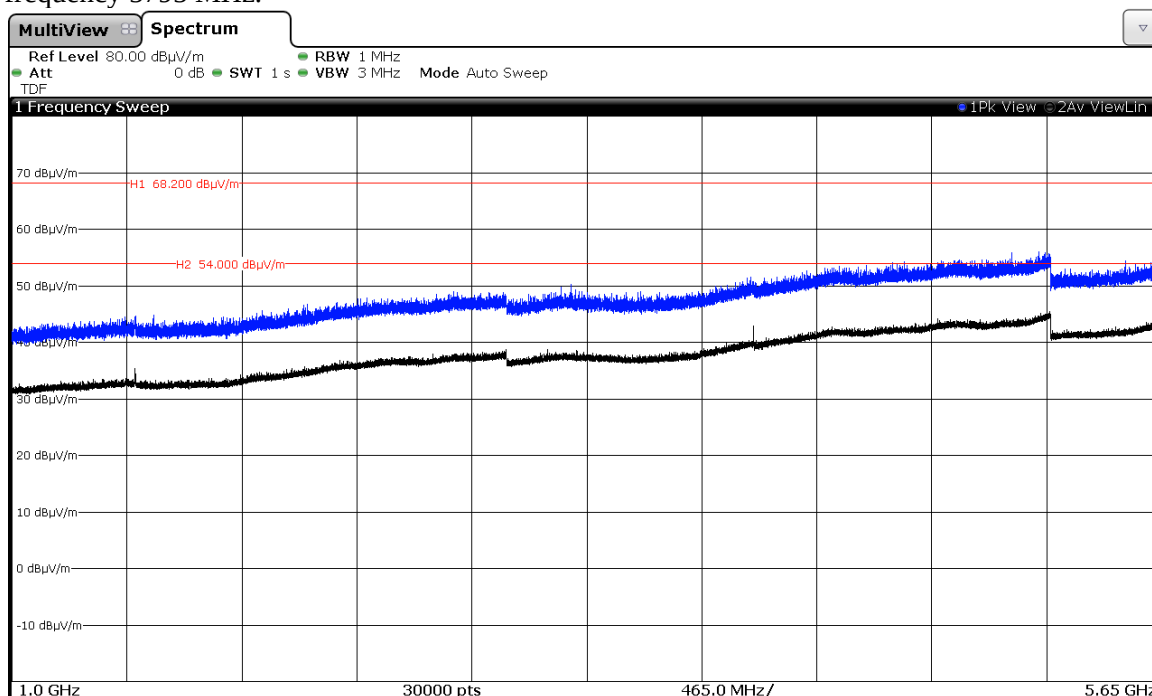
FREQUENCY RANGE 1 GHz to 5.65 GHz.

3. WiFi 5GHz 802.11 n40 mode

Lowest frequency 5755 MHz.



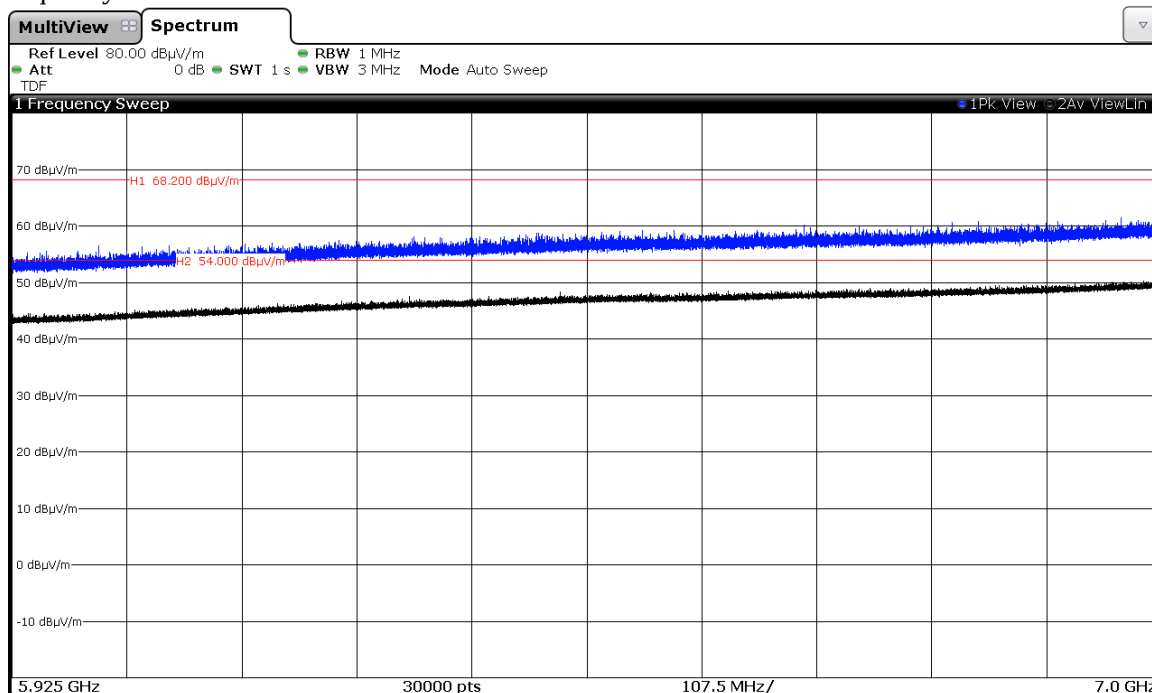
Highest frequency 5795 MHz.



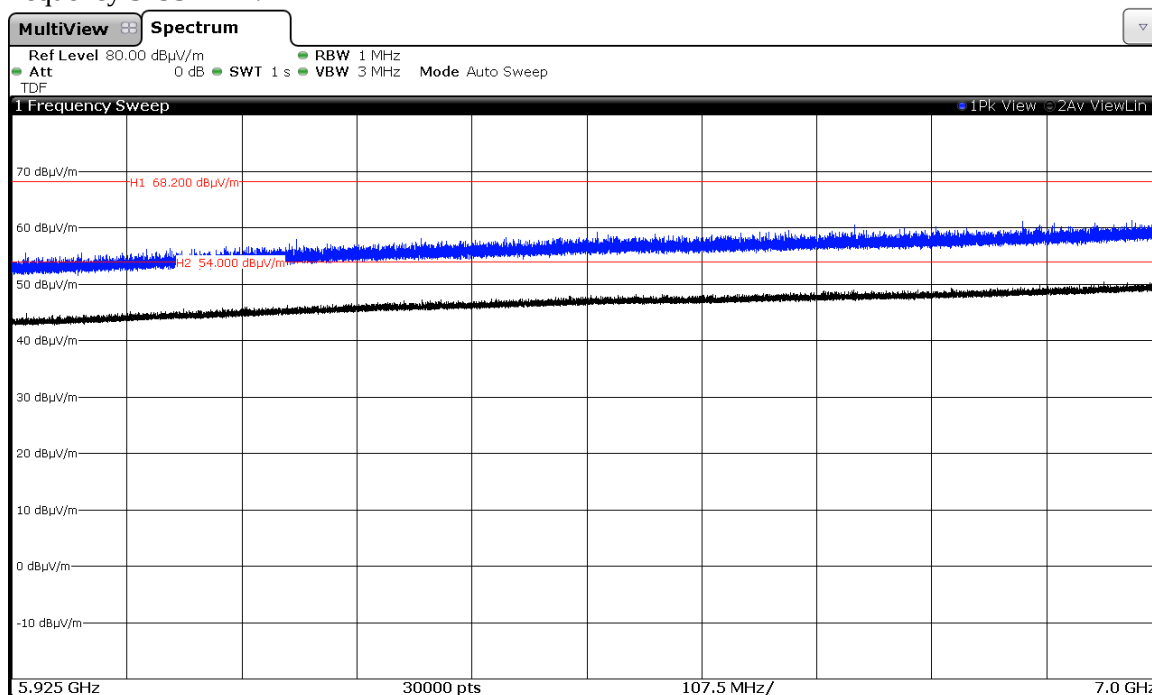
FREQUENCY RANGE 5.925 GHz to 7 GHz.

3. WiFi 5GHz 802.11 n40 mode

Lowest frequency 5755 MHz.



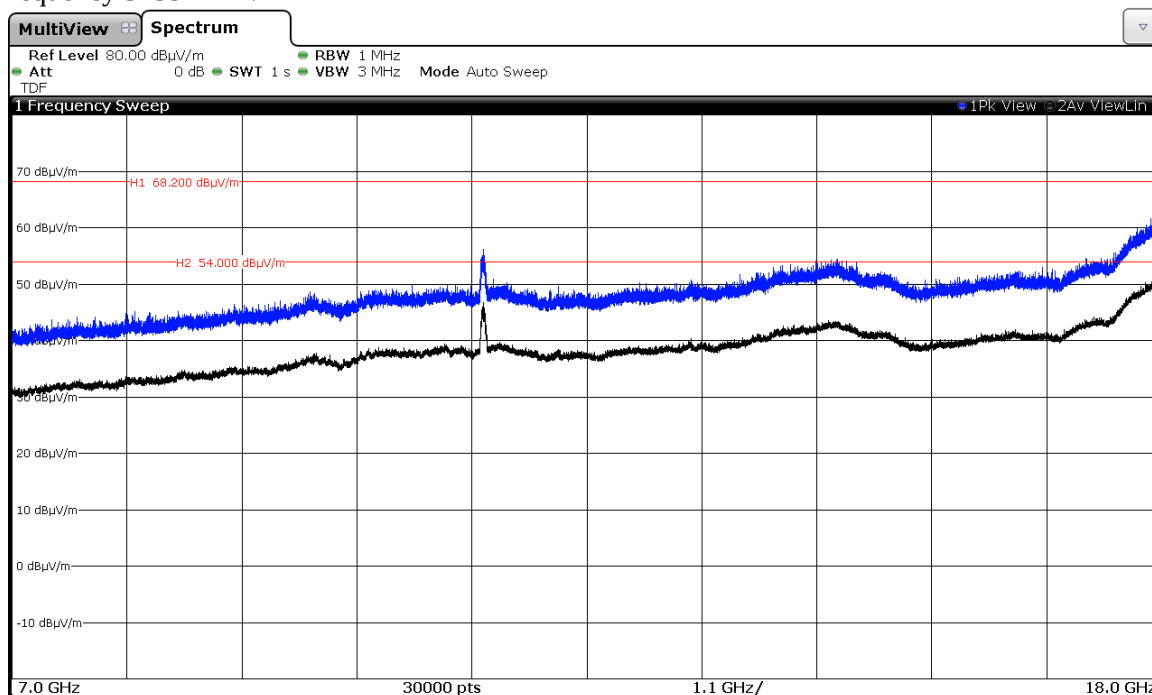
Highest frequency 5795 MHz.



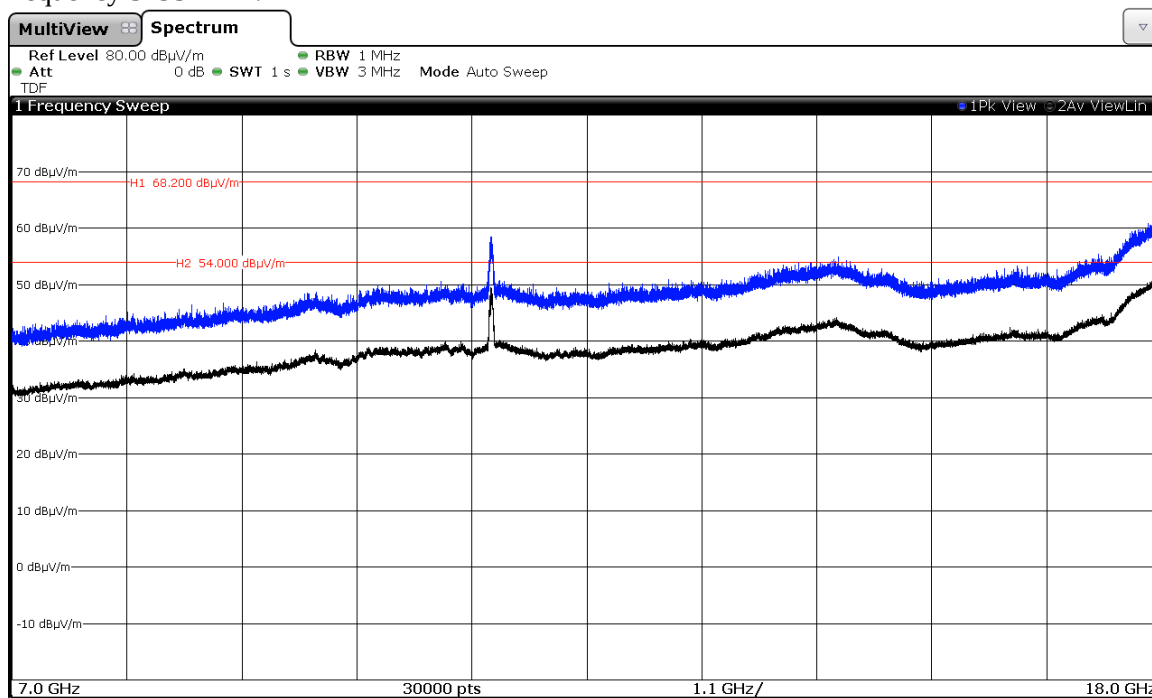
FREQUENCY RANGE 7 GHz to 18 GHz.

3. WiFi 5GHz 802.11 n40 mode

Lowest frequency 5755 MHz.



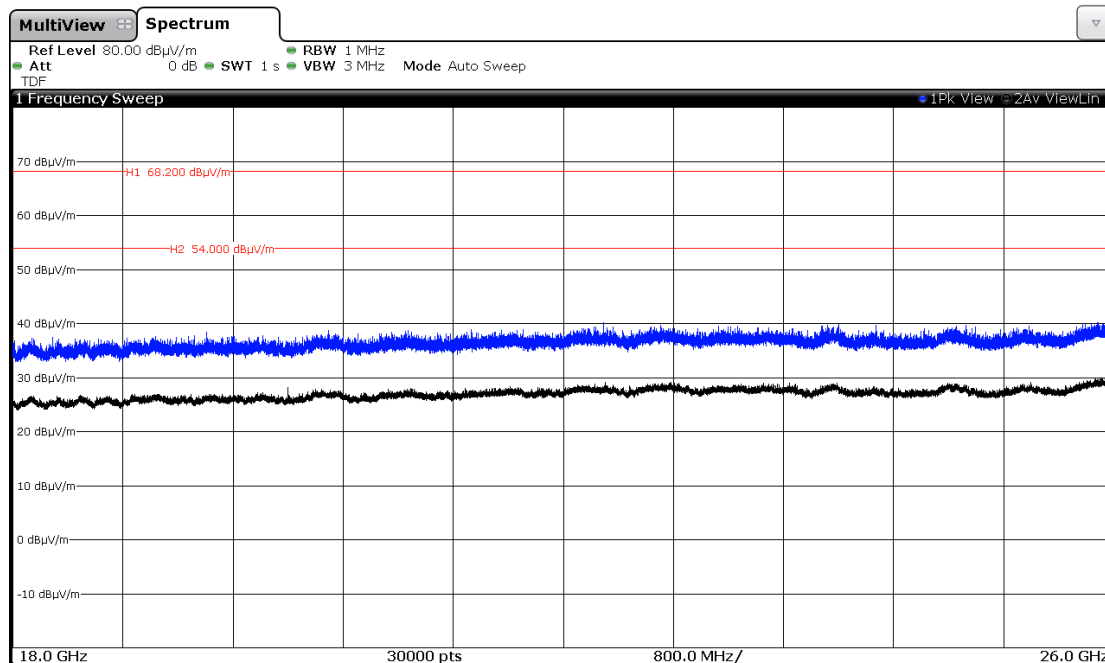
Highest frequency 5795 MHz.



FREQUENCY RANGE 18 GHz to 26GHz.

3. WiFi 5GHz 802.11 n40 mode

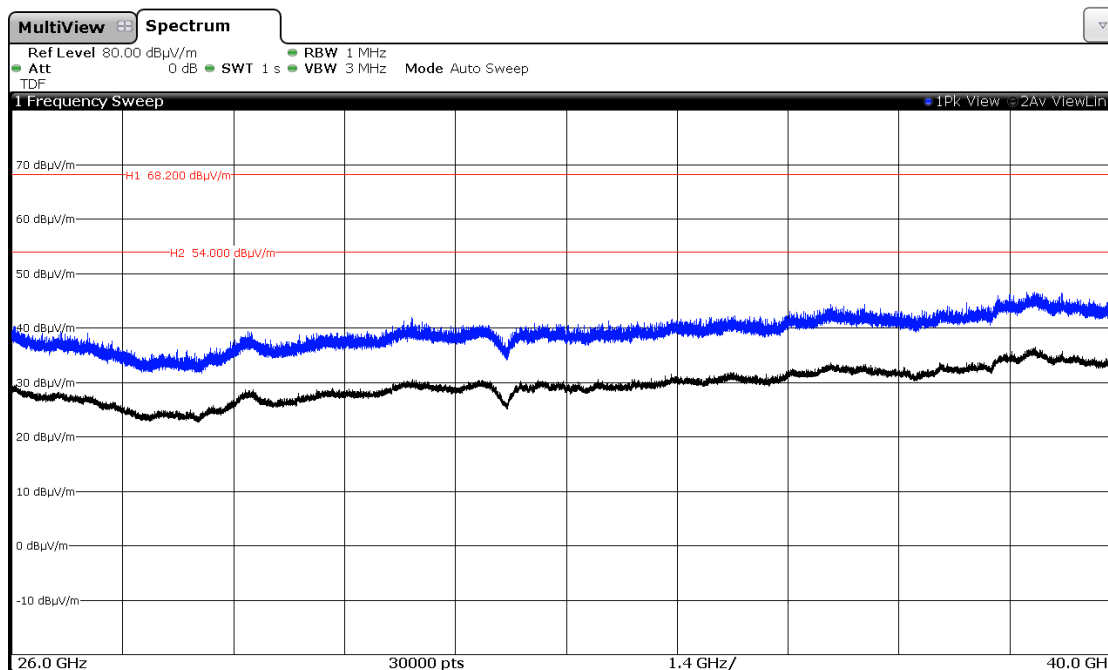
No spurious signals were found in all channels tested.



FREQUENCY RANGE 26 GHz 40GHz.

3. WiFi 5GHz 802.11 n40 mode

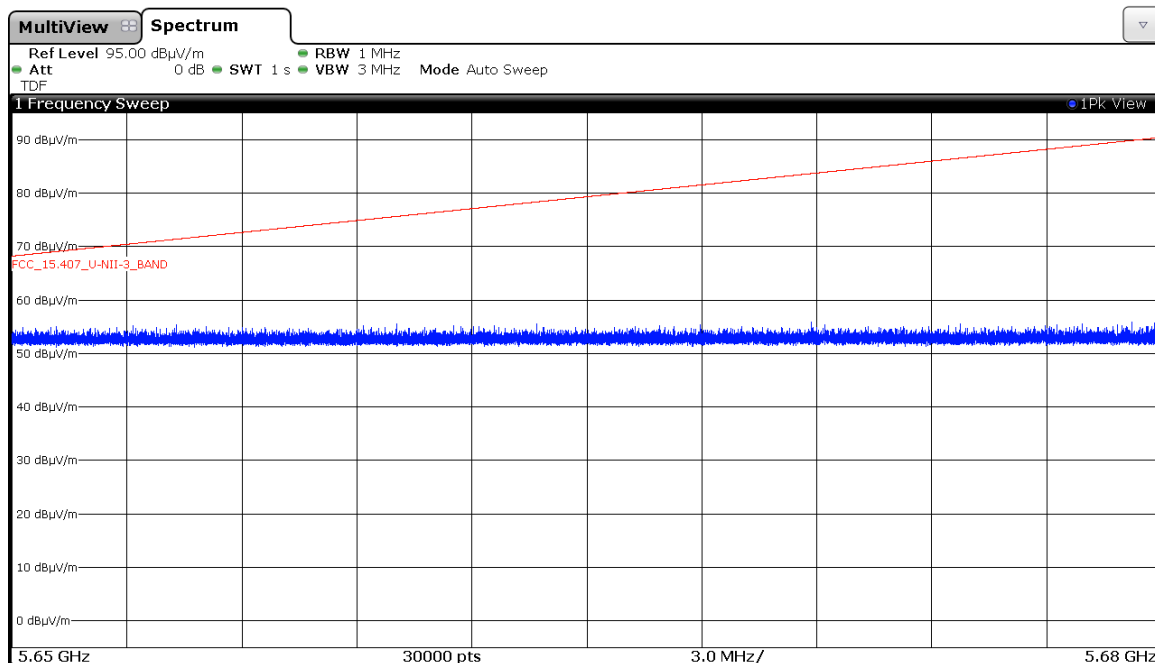
No spurious signals were found in all channels tested.



Radiated spurious emissions at band-edges and inside adjacent band 5.65 – 5.68 GHz.

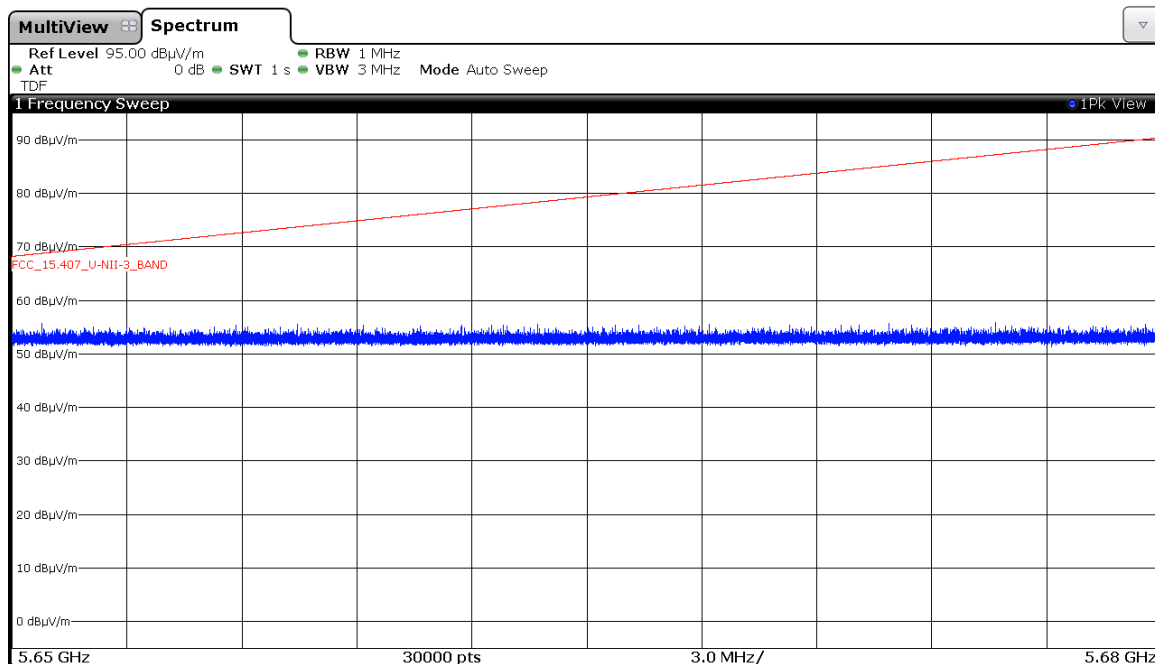
1. WiFi 5GHz 802.11 a mode

Lowest frequency 5745 MHz.



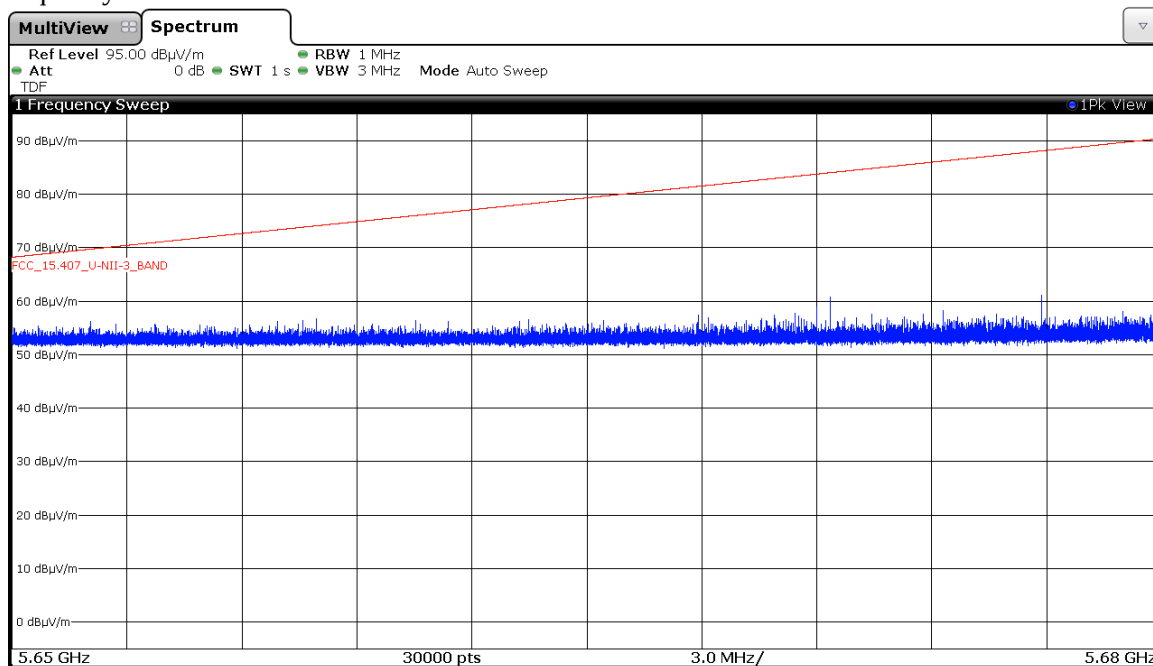
2. WiFi 5GHz 802.11 n20 mode

Lowest frequency 5745 MHz.



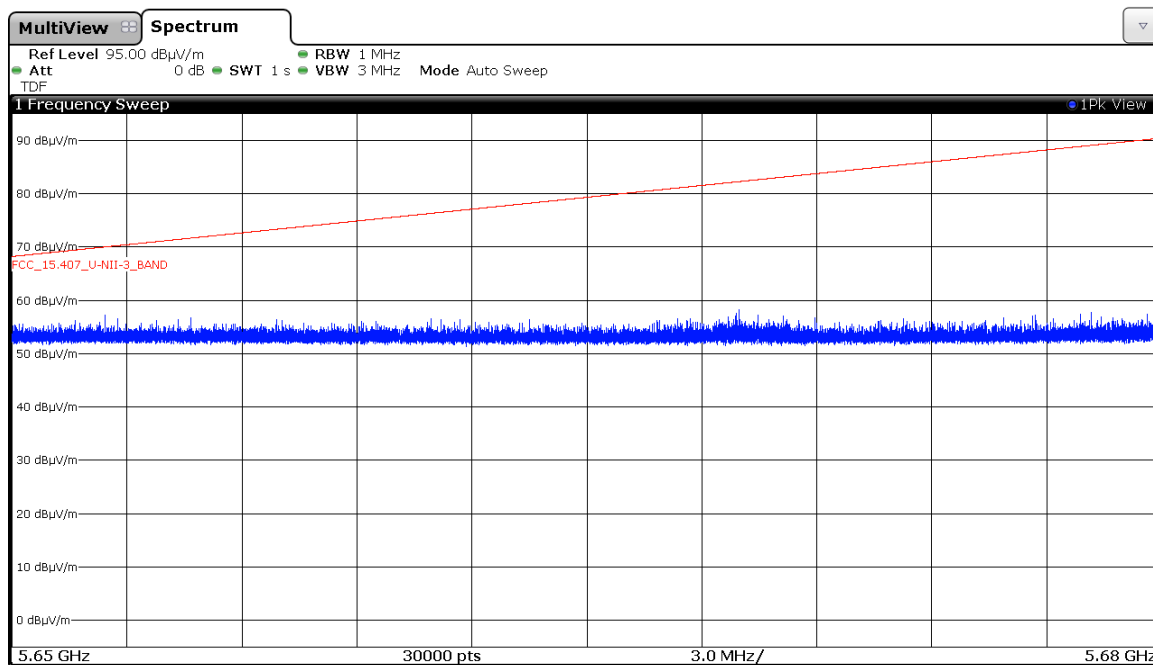
3. WiFi 5GHz 802.11 n40 mode

Lowest frequency 5755 MHz.



4. WiFi 5GHz 802.11 ac80 mode

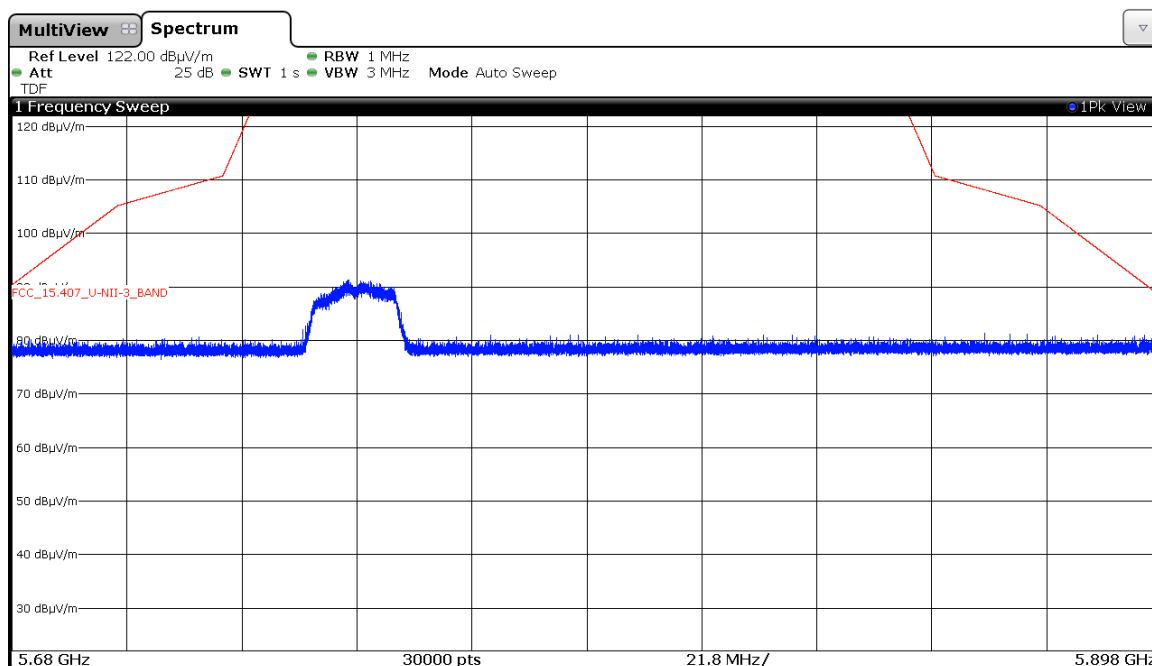
Middle frequency 5775 MHz.



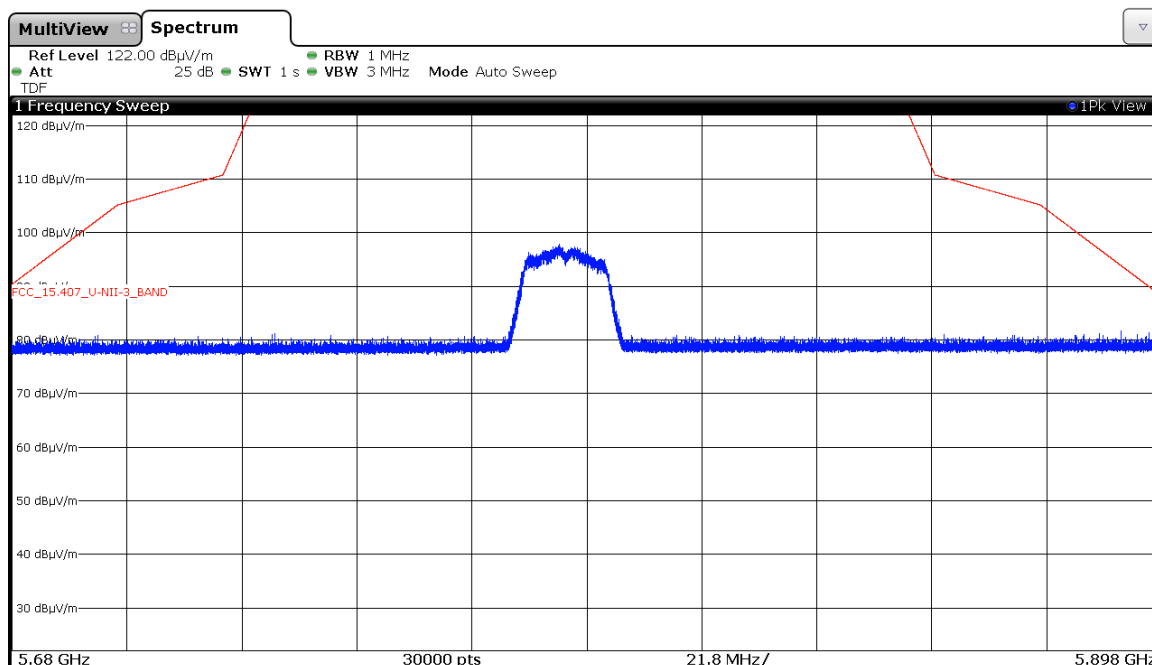
Radiated spurious emissions at band-edges and inside adjacent band 5.68 – 5.898 GHz.

1. WiFi 5GHz 802.11 a mode

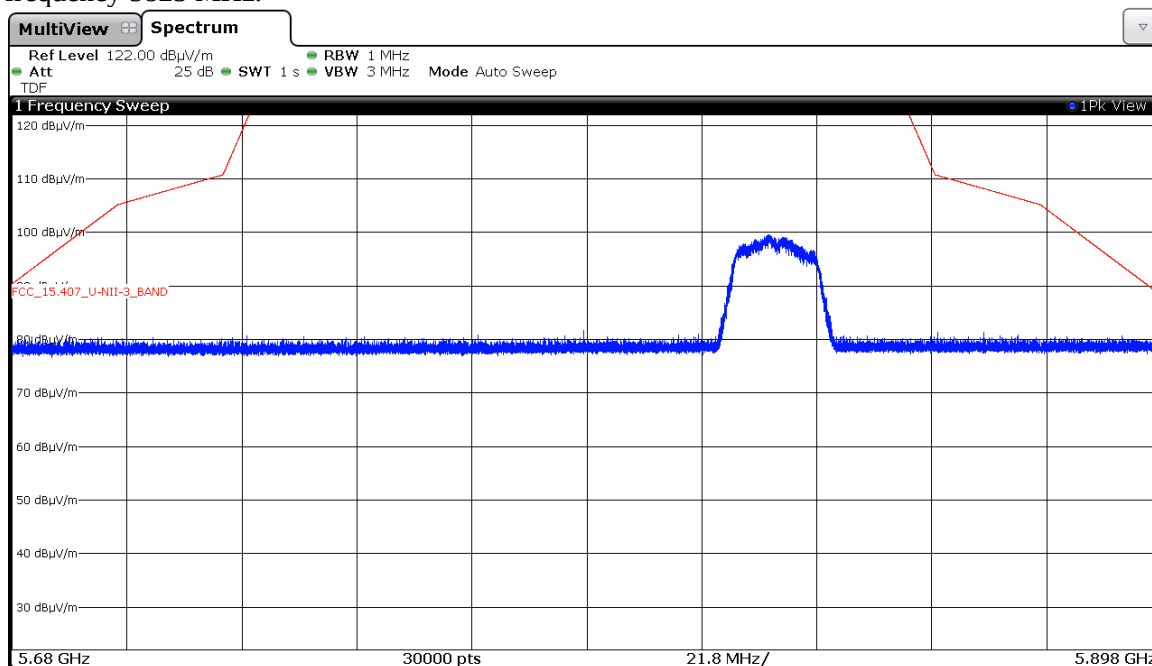
Lowest frequency 5745 MHz.



Middle frequency 5785 MHz.

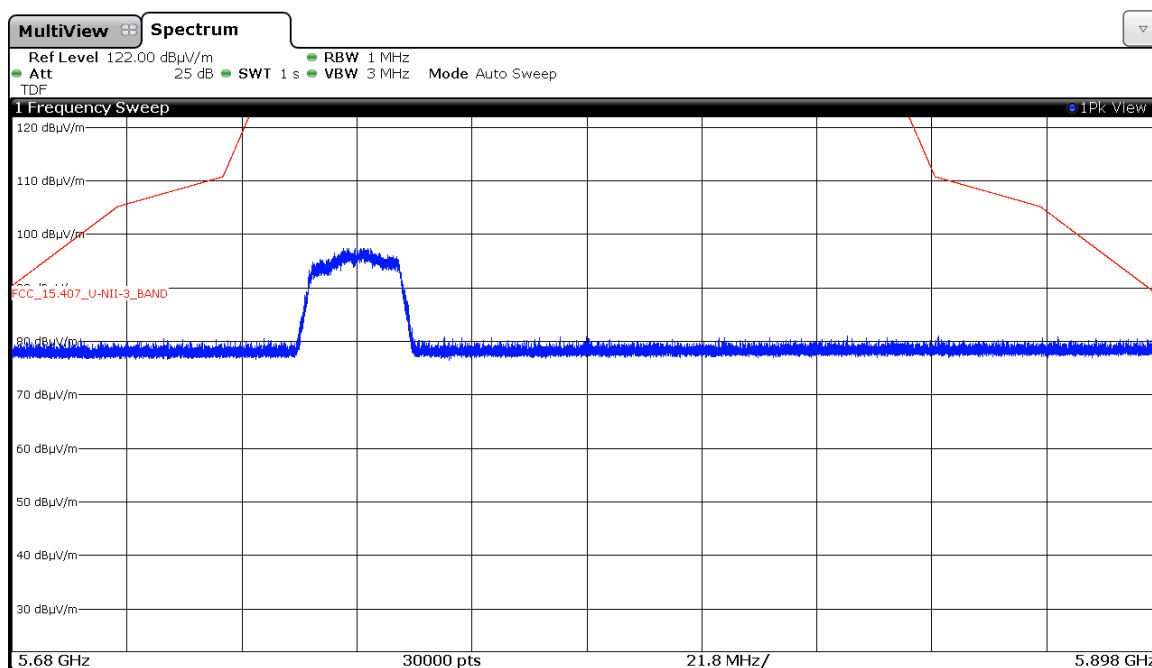


Highest frequency 5825 MHz.

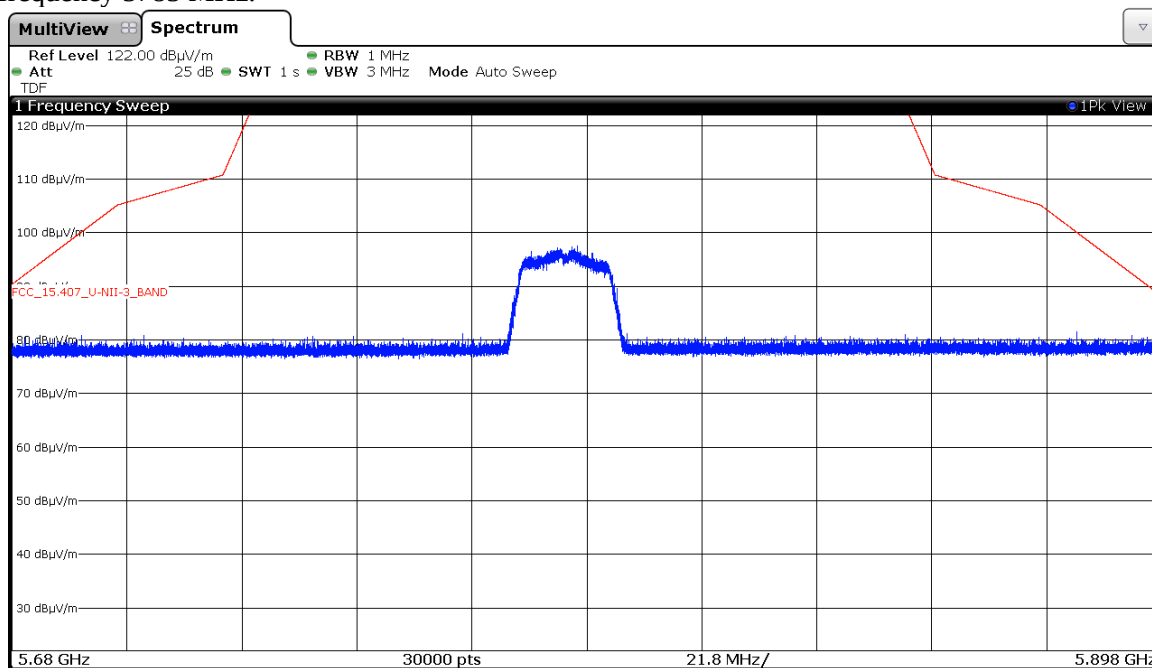


2. WiFi 5GHz 802.11 n20 mode

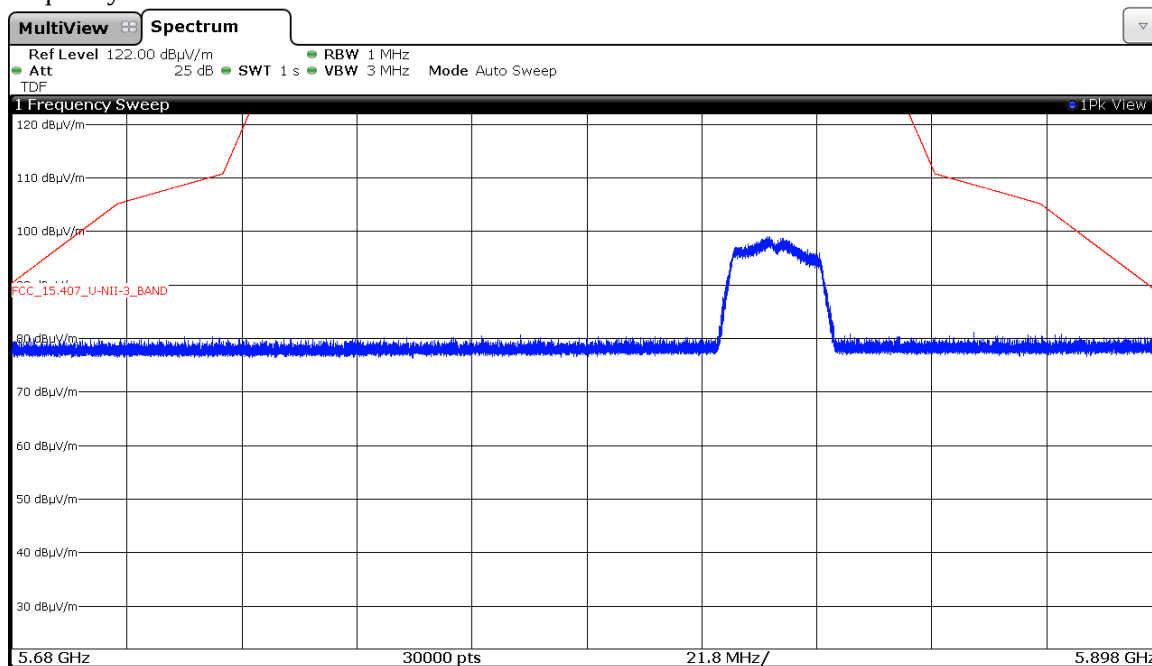
Lowest frequency 5745 MHz.



Middle frequency 5785 MHz.

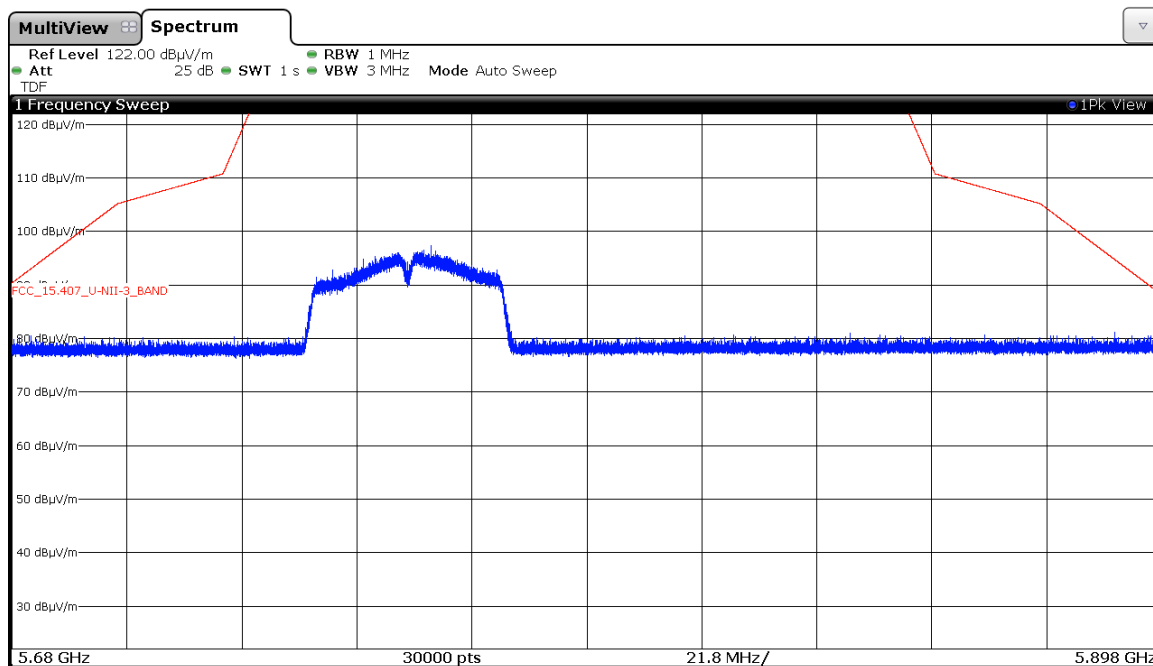


Highest frequency 5825 MHz.

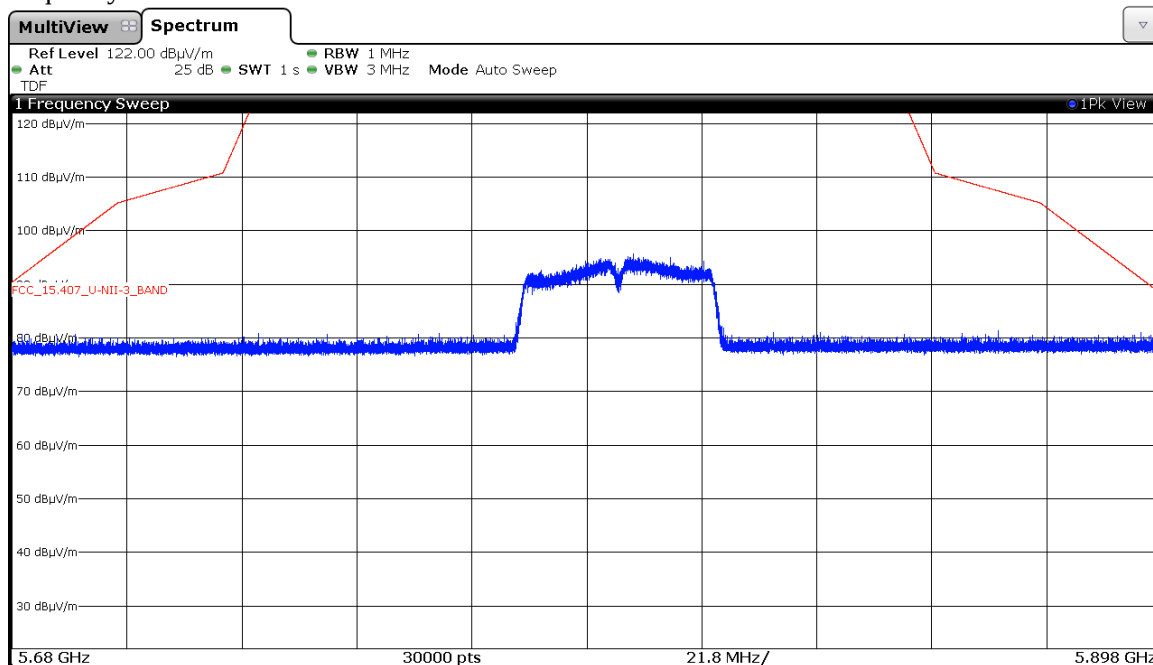


3. WiFi 5GHz 802.11 n40 mode

Lowest frequency 5755 MHz.

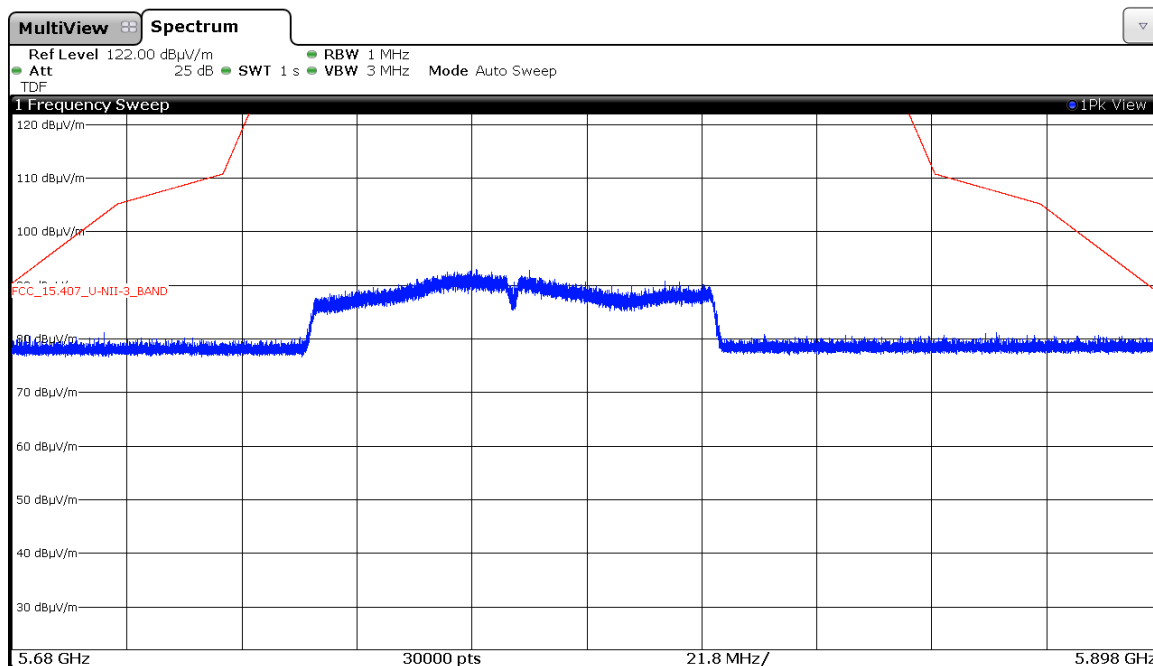


Highest frequency 5795 MHz.



4. WiFi 5GHz 802.11 ac80 mode

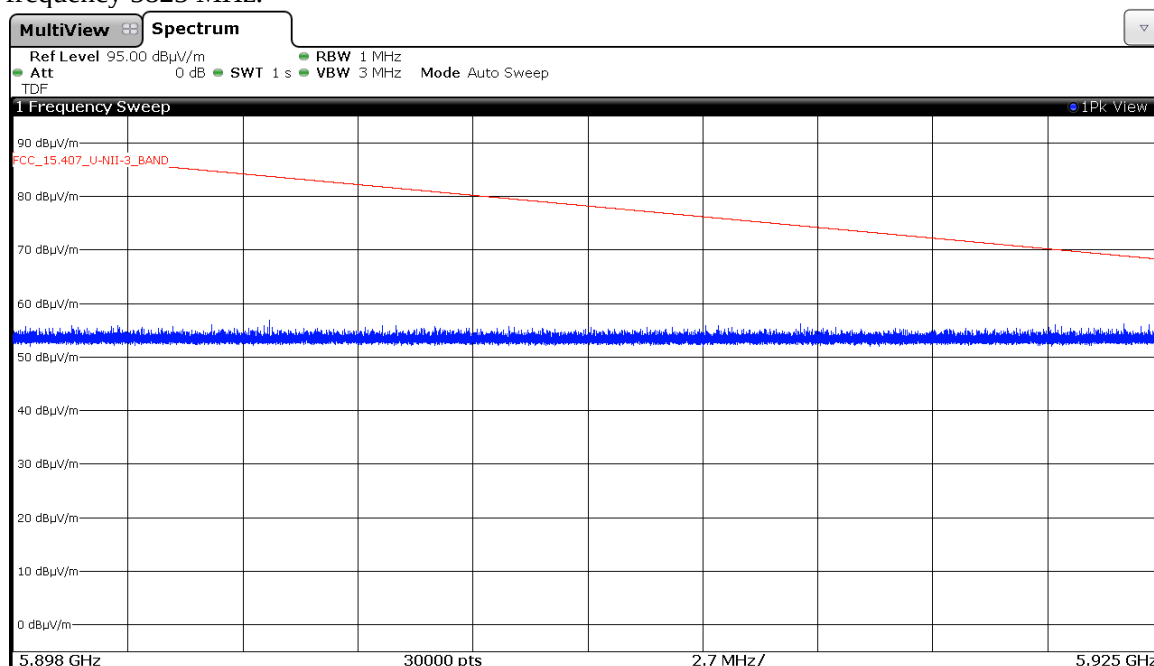
Middle frequency 5775 MHz.



Radiated spurious emissions at band-edges and inside adjacent band 5.898 – 5.925 GHz.

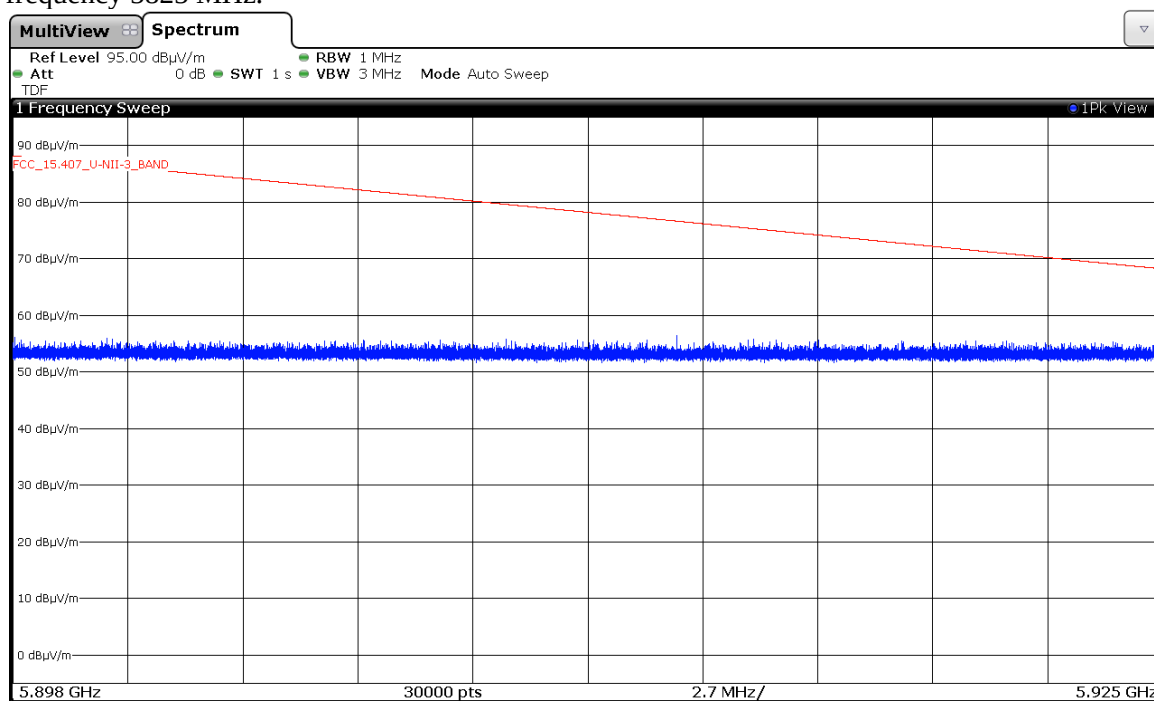
1. WiFi 5GHz 802.11 a mode

Highest frequency 5825 MHz.



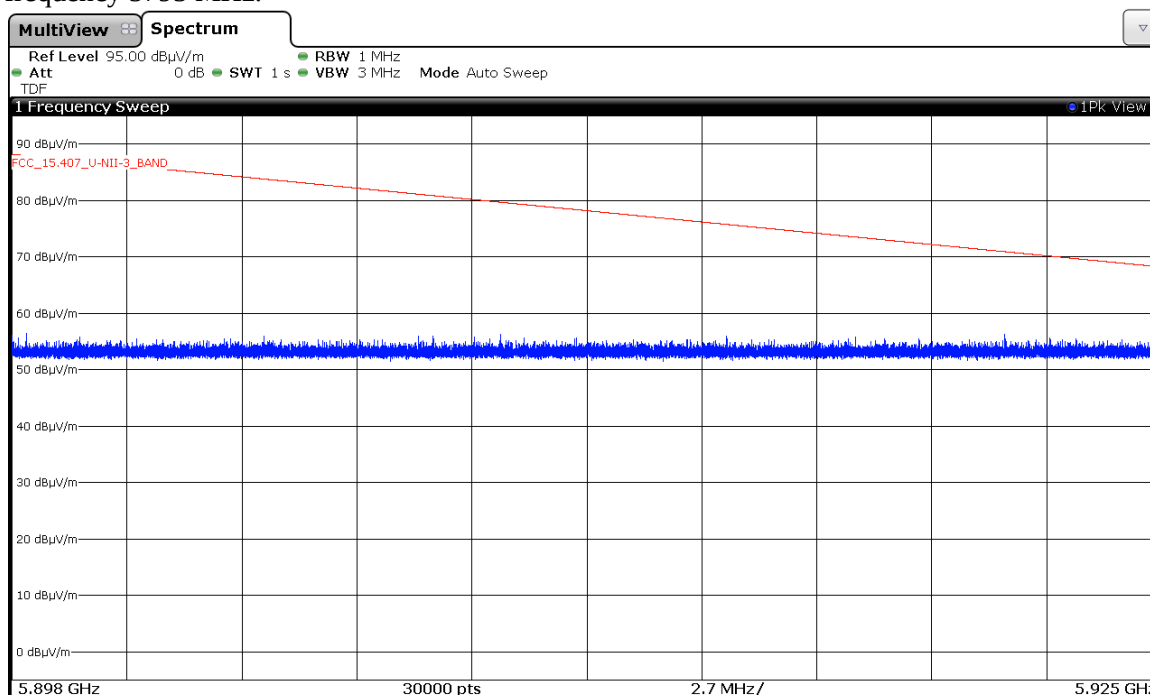
2. WiFi 5GHz 802.11 n20 mode

Highest frequency 5825 MHz.



3. WiFi 5GHz 802.11 n40 mode

Highest frequency 5795 MHz.



4. WiFi 5GHz 802.11 ac80 mode

Middle frequency 5775 MHz.

