



Test report No:
NIE: 60268RRF.011

Partial Test Report

USA FCC Part 15.407, 15.209

CANADA RSS-247, RSS-Gen

Unlicensed National Information Infrastructure (U-NII) 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.

General Requirements and Information for the Certification of Radio Apparatus.

(*) Identification of item tested	Automotive infotainment System
(*) Trademark	Mercedes-Benz
(*) Model and /or type reference	NTG7 HIGH
Other identification of the product	HW version: D5 SW version: E17.100 FCC ID: T8GNTG7HIGH IC: 6434A-NTG7HIGH
(*) Features	FM/AM/DAB/DVBT USB, Bluetooth, WLAN, GNSS.
Applicant	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY
Test method requested, standard	USA FCC Part 15.407 (10-1-19) Edition: Unlicensed National Information Infrastructure (U-NII) Devices. General technical requirements. - Transmitter Out of Band Radiated Emissions. - Transmitter Band Edge Radiated Emissions. USA FCC Part 15.209 (10-1-19) Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). - Transmitter Out of Band Radiated Emissions. - Transmitter Band Edge Radiated Emissions. CANADA RSS-Gen Issue 5 (March 2019). Guidance for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Approved by (name / position & signature)	Jose Carlos Luque RF Lab. Supervisor
Date of issue	2020-05-25
Report template No	FDT08_22
	(*) "Data provided by the client"

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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 FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

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.

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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.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample of the model NTG7 HIGH is an automotive head unit to be installed in cars with the following features: FM/AM/DAB/DVBT, USB, Bluetooth, WLAN and GNSS.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of result.

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
60268/302	Automotive Infotainment System	NTG7 HIGH	HBM609LS000001	2020/02/26
60268/308	Cable RF Harness	--	--	2020/02/26
60268/122	Antennas	--	--	2019/09/30

Sample S/01 has undergone the following test(s): All RADIATED tests indicated in Appendixes A and B.

Test sample description

Ports..... :	Port name and description		Cable			
			Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾
	Car Connector A		>3m ^(x1)	☒	☐	☐
	Car Connector B		>3m ^(x1)	☒	☐	☐
	Display Connector CID/PIP / RVC		>3m ^(x1)	☒	☒	☐
	USB Connector		<3m ^(x2)	☒	☒	☐
	Eth Connector		>3m ^(x1)	☒	☐	☐
	BT/WLAN-Antenna		>3m ^(x1)	☒	☒	☐
	FM/AM, TV/SDARS Ant		>3m ^(x1)	☒	☒	☐
	GNSS Antenna		>3m ^(x1)	☒	☒	☐
Supplementary information to the ports..... :						
Rated power supply	Voltage and Frequency					
	☒	DC: 12V Car battery / attenuator (9,5-15,5V normal operation)				
Rated Power	9,5-15,5V normal operation					
Clock frequencies.....:	See schematics					

Other parameters	See Technical Description		
Software version	E17.100		
Hardware version	D5		
Dimensions in cm (W x H x D)	182 x 78 x 160 mm		
Mounting position	☒	Other: automotive headunit	
Modules/parts.....	Module/parts of test item	Type	Manufacturer
	N/A	-	
Accessories (not part of the test item)	Description	Type	Manufacturer
	Display	-	LG.
	HARMANeco RasPi	-	HBAS
	Cable harness	-	HBAS
	BT/WLAN-Antenna	-	Hirschmann
Documents as provided by the applicant	Description	File name	Issue date
	Technical Description		

⁽³⁾ Only for Medical Equipment

Identification of the client

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

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-03-12
Date (finish)	2020-03-16

Document history

Report number	Date	Description
60268RRF.011	2020-05-25	First release

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 %

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

Remarks and comments

The tests have been performed by the technical personnel: José Manuel Jiménez.

Used instrumentation:

Radiated Measurements:

		Last Calibration	Due Calibration
1.	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
3.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2018/10	2020/10
4.	RF Pre-amplifier, G>40 dB, 10 MHz-6 GHz BONN ELEKTRONIK BLNA 0160-01N	2020/02	2021/02
5.	Hybrid Bilog Antenna 30 MHz – 6 GHz ETS LINDGREN 3142E	2017/09	2020/09
6.	Signal and Spectrum Analyzer 10 Hz-40 GHz ROHDE AND SCHWARZ FSV40	2019/10	2021/10
7.	RF Pre-amplifier, G>30 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-3A	2019/11	2020/11
8.	RF Pre-amplifier, G>30dB, 18-40GHz BONN ELEKTRONIK BLMA 1840-1M	2019/02	2021/02
9.	Broadband Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2018/01	2021/01
10.	Broadband Horn antenna 18 - 40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2018/07	2021/07
11.	DC Power Supply Keysight Technologies U8002A	N.A.	N.A.
12.	Digital multimeter FLUKE 175	2019/10	2020/10

Testing verdicts

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

Summary

A. U-NII-1 Band: 5.15 - 5.25 GHz

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		Verdict	Remark
FCC 15.407 (a)(1)(iv)	Transmitter Maximum conducted Output Power	N/M	
RSS-247 6.2.1.1	Transmitter Maximum Equivalent Isotropically Radiated Power EIRP	N/M	
FCC 15.407 (a)(1)(iv)	Transmitter Maximum Power Spectral Density	N/M	
RSS-247 6.2.1.1	Transmitter EIRP Spectral Density	N/M	
FCC 15.407 (b)(1)(6) / RSS-247 6.2.1.2	Transmitter Out of Band Radiated Emissions	P	
FCC 15.407 (b)(1) / RSS-247 6.2.1.2	Transmitter Band Edge Radiated Emissions	P	
FCC 15.407 (h)(1) / RSS-247 6.2.1.1	Transmitter Power Control	N/M	
<u>Supplementary information and remarks:</u>			
None.			

B. U-NII-3 Band: 5.725 - 5.85 GHz

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		Verdict	Remark
FCC 15.407 (a)(3) / RSS-247 6.2.4.1	Transmitter Maximum conducted Output Power	N/M	
FCC 15.407 (e) / RSS-247 Clause 6.2.4.1	6 dB bandwidth.	N/M	
FCC 15.407 (a)(3) / RSS-247 Clause 6.2.4.1	Transmitter Maximum Power Spectral Density	N/M	
FCC 15.407 (b)(4) / RSS-247 6.2.4.2	Transmitter Band Edge Radiated Emissions	P	
FCC 15.407 (b)(4)(6) / RSS-247 6.2.4.2	Transmitter Out of Band Radiated Emissions	P	
FCC 15.40 (h)(1) / RSS-247 6.2.4.1	Transmitter Power Control	N/A	
<u>Supplementary information and remarks:</u>			
None.			

Appendix A: Tests results for the U-NII-1 Band 5.15 – 5.25 GHz

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TEST CONDITIONS

POWER SUPPLY (V):

Vnominal: 12 Vdc
Type of Power Supply: External DC (Vehicle battery).

ANTENNA:

Type of Antenna: External.
Maximum Declared Assembly Antenna Gain: +2.5 dBi

TEST FREQUENCIES:

Technology Tested:	WLAN (IEEE 802.11 a,n,ac) / U-NII-1	
Modes:	802.11a20: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps	
	802.11n HT20: MCS0 to MCS7	
	802.11n HT40: MCS0 to MCS7	
	802.11ac VHT20: MCS0 to MCS9	
	802.11ac VHT40: MCS0 to MCS9	
	802.11ac VHT80: MCS0 to MCS9	
Setting of cores / ports:	One port. SISO: CORE0_Port3.	
Beamforming:	No.	
Frequency Range:	5150 MHz to 5250 MHz	
Channel Spacing:	20 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Lowest: 36	5180
	Middle: 40	5200
	Highest: 48	5240
Channel Spacing:	40 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Lowest: 38	5190
	Highest: 46	5230
Channel Spacing:	80 MHz	
Transmit Channels	Middle: 42	5210

The test set-up was made in accordance to the general provisions of FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

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 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 instructions 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:

- 802.11a20: 6 Mbits
- 802.11n HT20: MCS0
- 802.11n HT40: MCS0
- 802.11ac VHT20: MCS0
- 802.11ac VHT40: MCS0
- 802.11ac VHT80: MCS0

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).

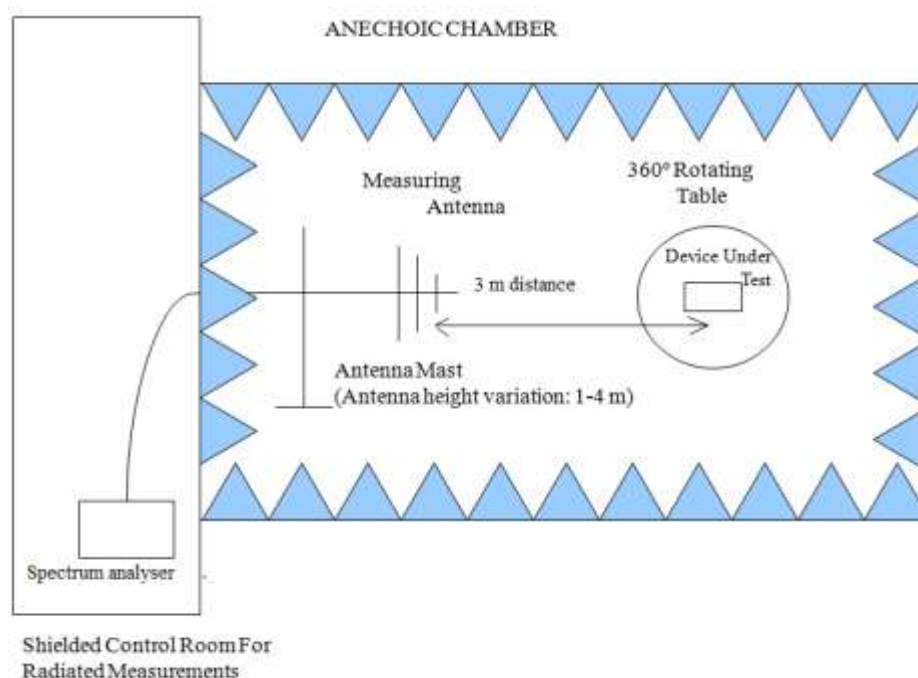
For radiated emissions in the range 1 GHz-40 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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.

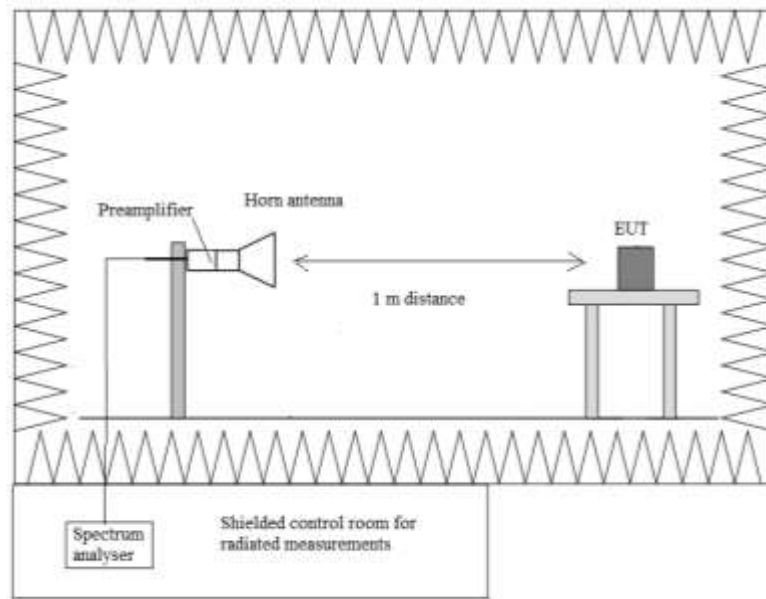
Measurements were made in both horizontal and vertical planes of polarization.

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

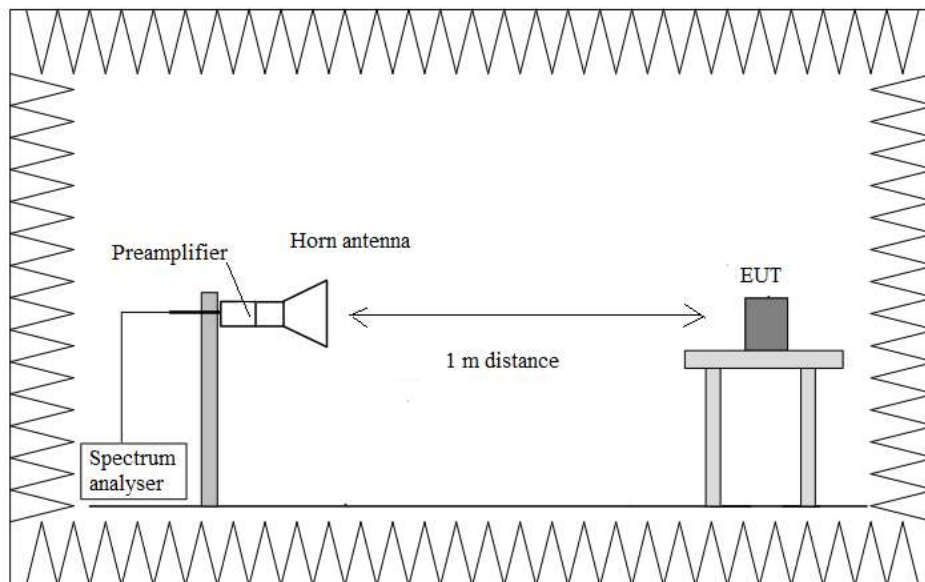
Radiated measurements setup $f < 1$ GHz.



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



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



FCC 15.407 (b)(1)(6) / RSS-247 6.2.1.2. Transmitter Out of Band Radiated Emissions

SPECIFICATION:

For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.23 dBμV/m at 3 m distance).

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 (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
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° 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.

All tests were performed in a semi-anechoic chamber at a distance of 1m for the frequency range 1 GHz-40 GHz and a distance of 3m for frequency range 30MHz-1GHz.

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.

- Test performed on the worst case: 802.11 n20 (MSC0).

The worst case was determined by measuring the eirp density (radiated).

Frequency range 30 MHz - 1 GHz

The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
45.3750	32.6	V	Quasi-peak	<± 5.08
90.5120	35.2	V	Quasi-peak	<± 5.08
237.208	29.8	H	Quasi-peak	<± 5.08
278.466	29.9	H	Quasi-peak	<± 5.08
500.014	35.2	H	Quasi-peak	<± 5.08
525.007	33.4	V	Quasi-peak	<± 5.08
801.328	27.0	V	Quasi-peak	<± 5.08
958.339	36.1	V	Quasi-peak	<± 5.08

Frequency range 1 - 40 GHz

The results in the next tables show the maximum measured levels in the 1-40 GHz frequency range.

The Low, Middle and High Channels were measured for out-of-band emissions for the worst mode.

Spurious frequencies in the restricted bands with peak levels above the average limit (54 dBμV/m at 3 m) are measured with an average detector for checking compliance with the average limit.

- 802.11 n20 (worst case):**

- LOW CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
10.35217	60.48	H	Peak	<±5.13
39.55725	50.12	H	Peak	<±5.14

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.050100	50.48	H	Peak	<±4.11
6.173960	54.59	V	Peak	<±4.11
10.39683	59.17	H	Peak	<±5.13
39.58025	49.89	V	Peak	<±5.14

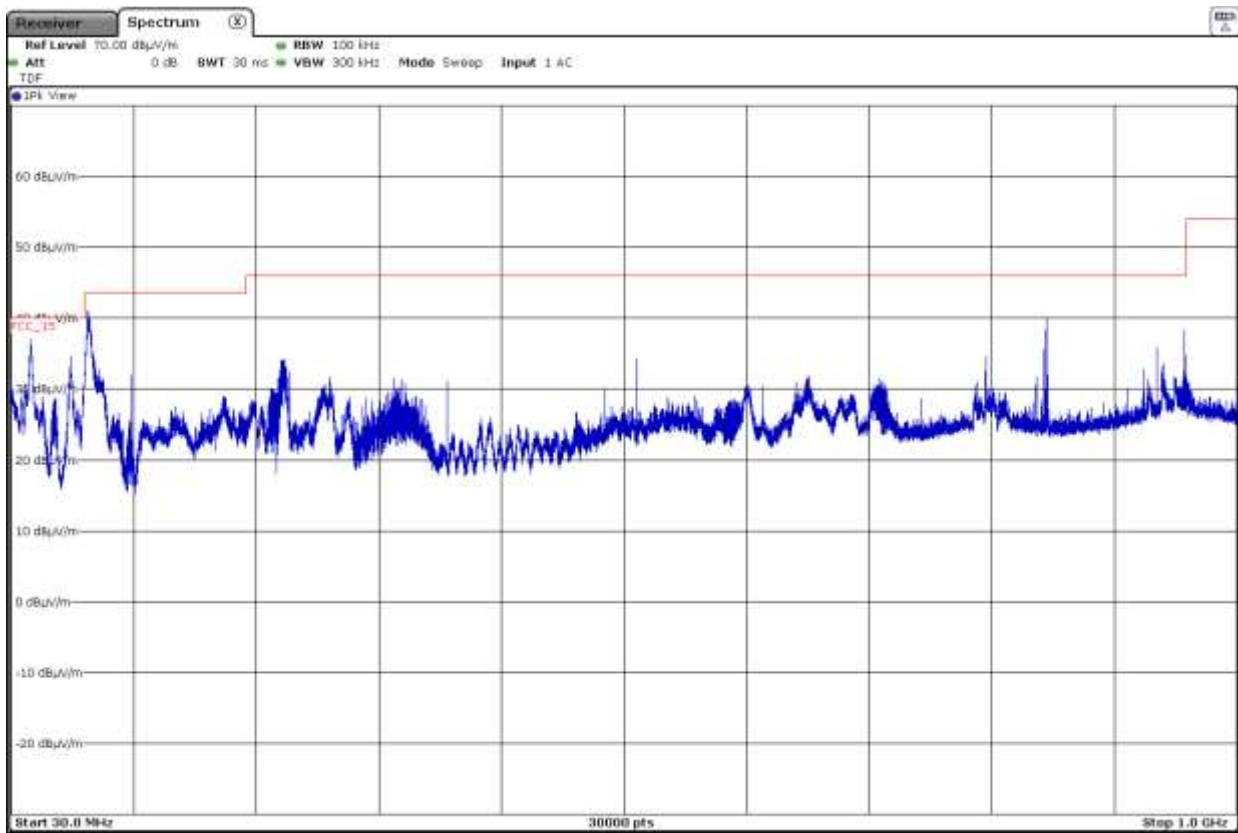
- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
10.48283	60.58	H	Peak	<±5.13
39.54192	49.72	H	Peak	<±5.14

Verdict: PASS

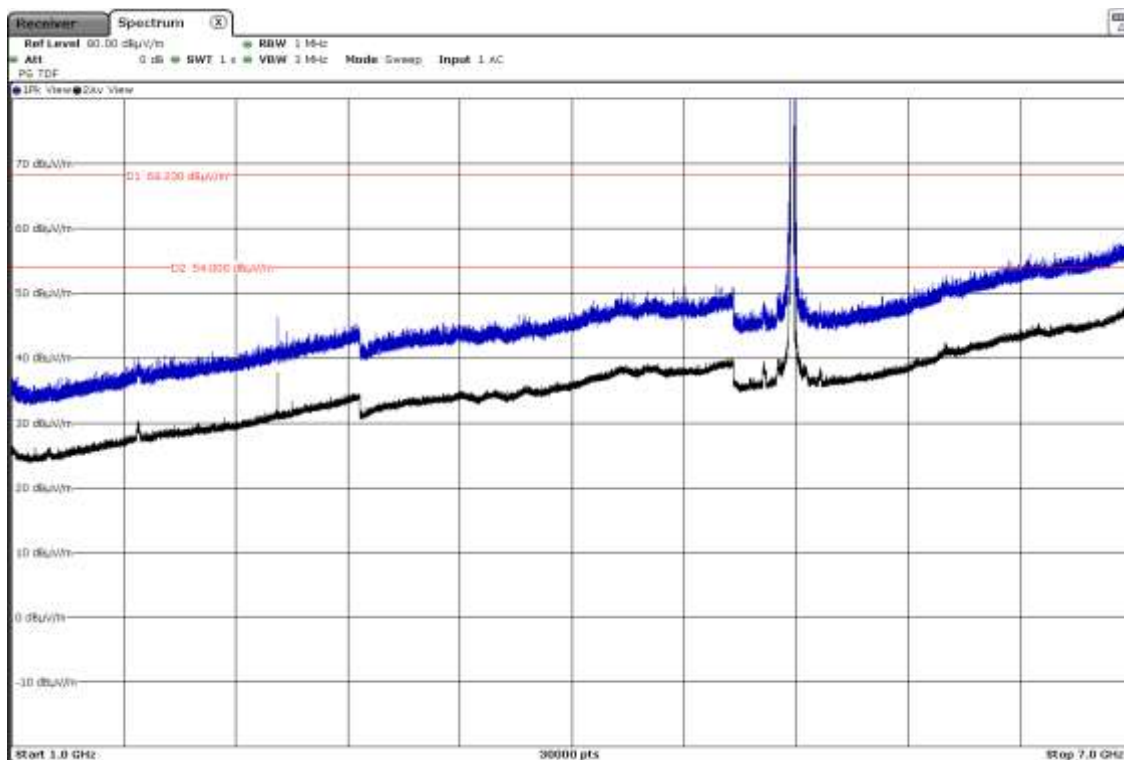
FREQUENCY RANGE 30 MHz - 1 GHz

This plot is valid for the Low, Middle and High Channels and all the modulation modes.



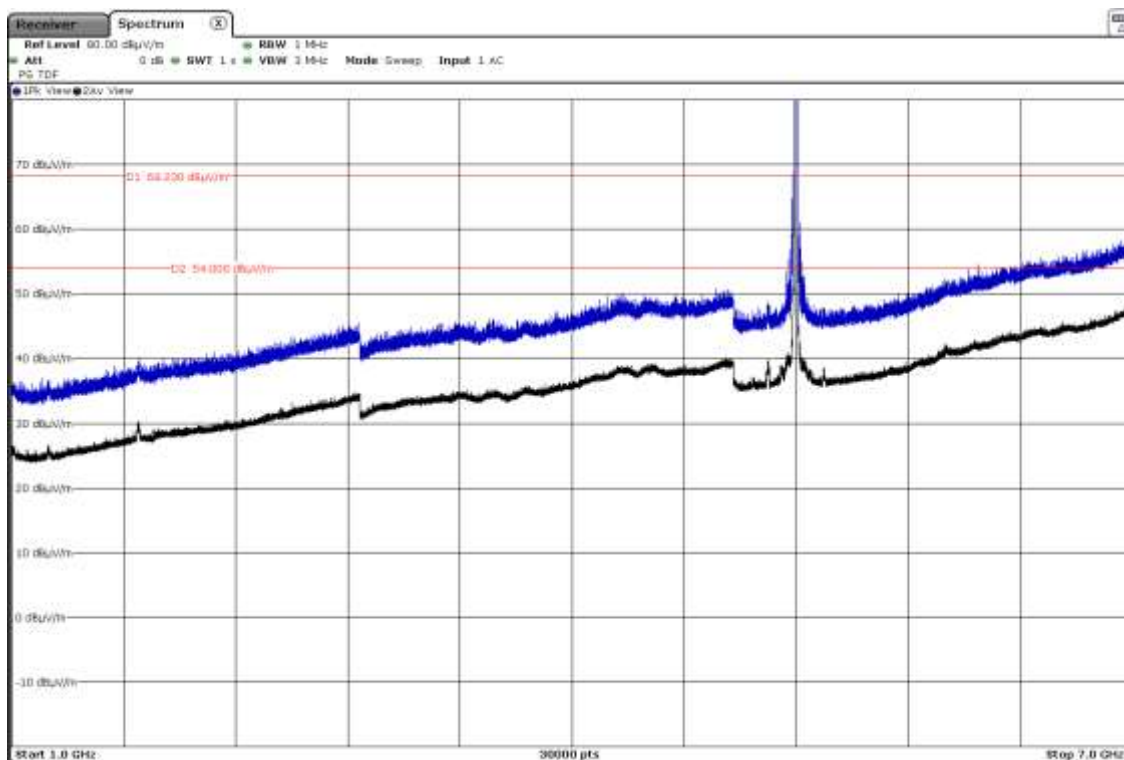
FREQUENCY RANGE 1 – 7 GHz (worst mode)

- Low Channel:



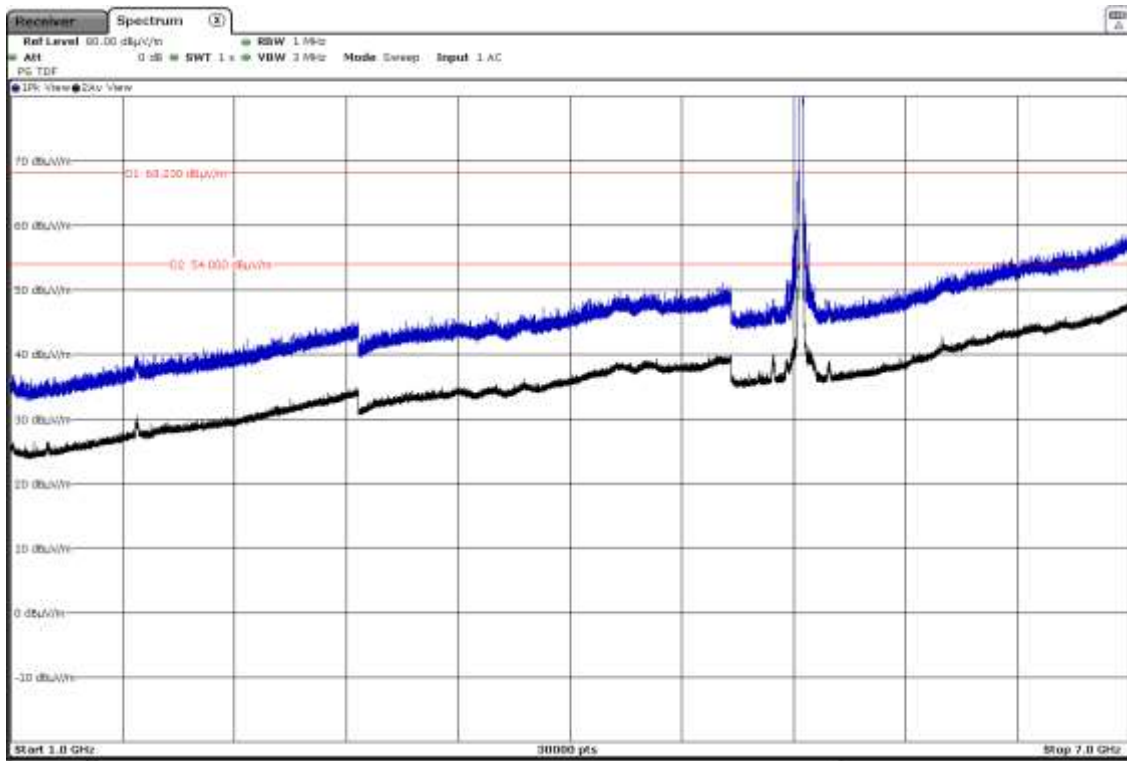
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

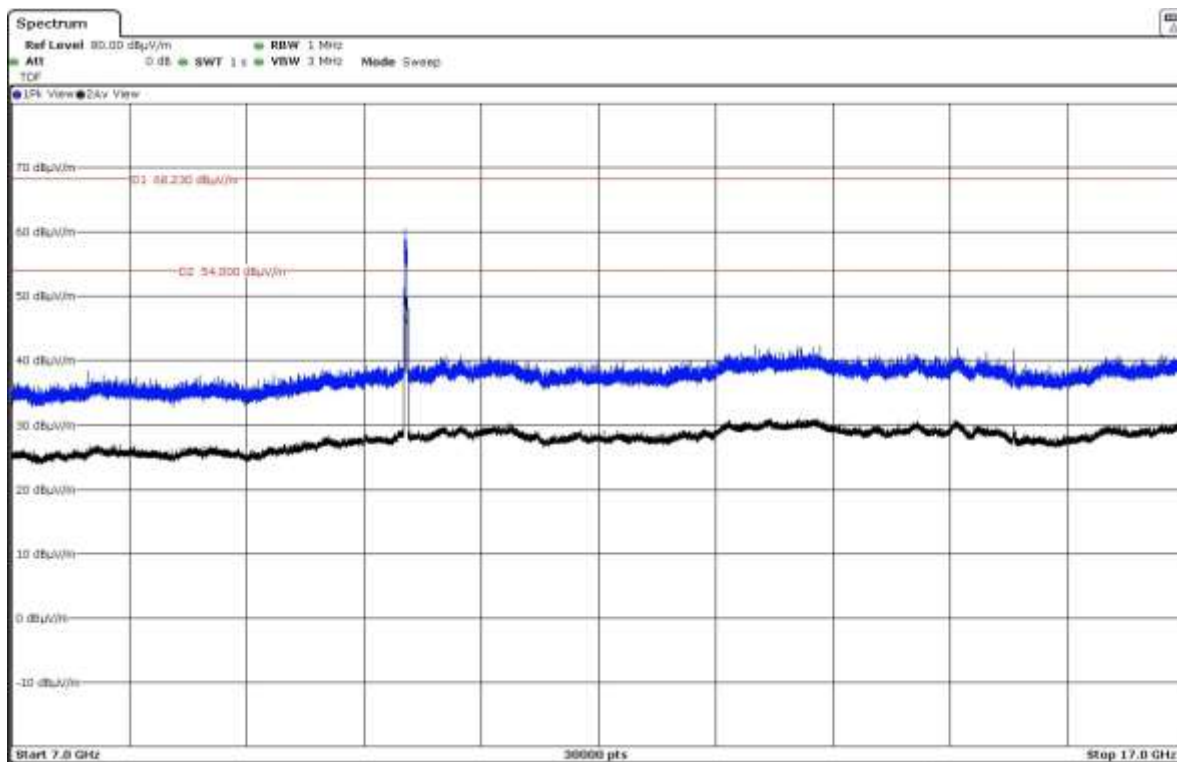
- High Channel:



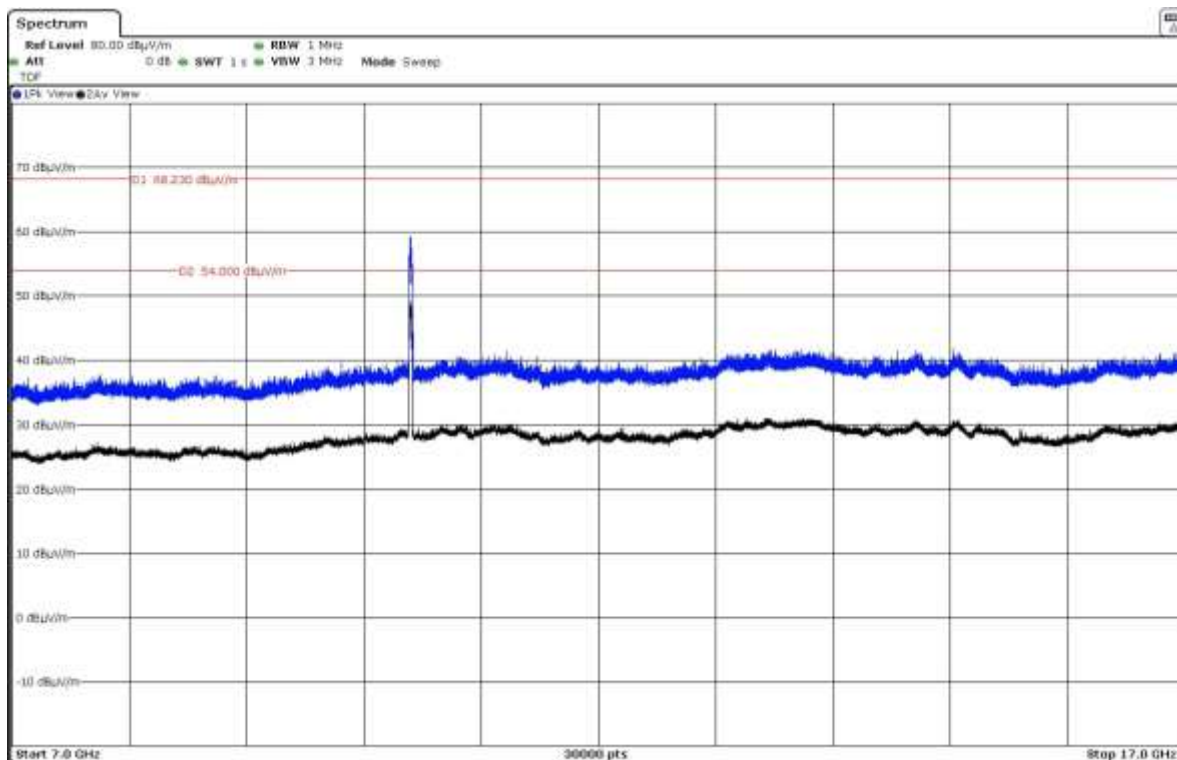
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 7 - 17 GHz. (worst mode)

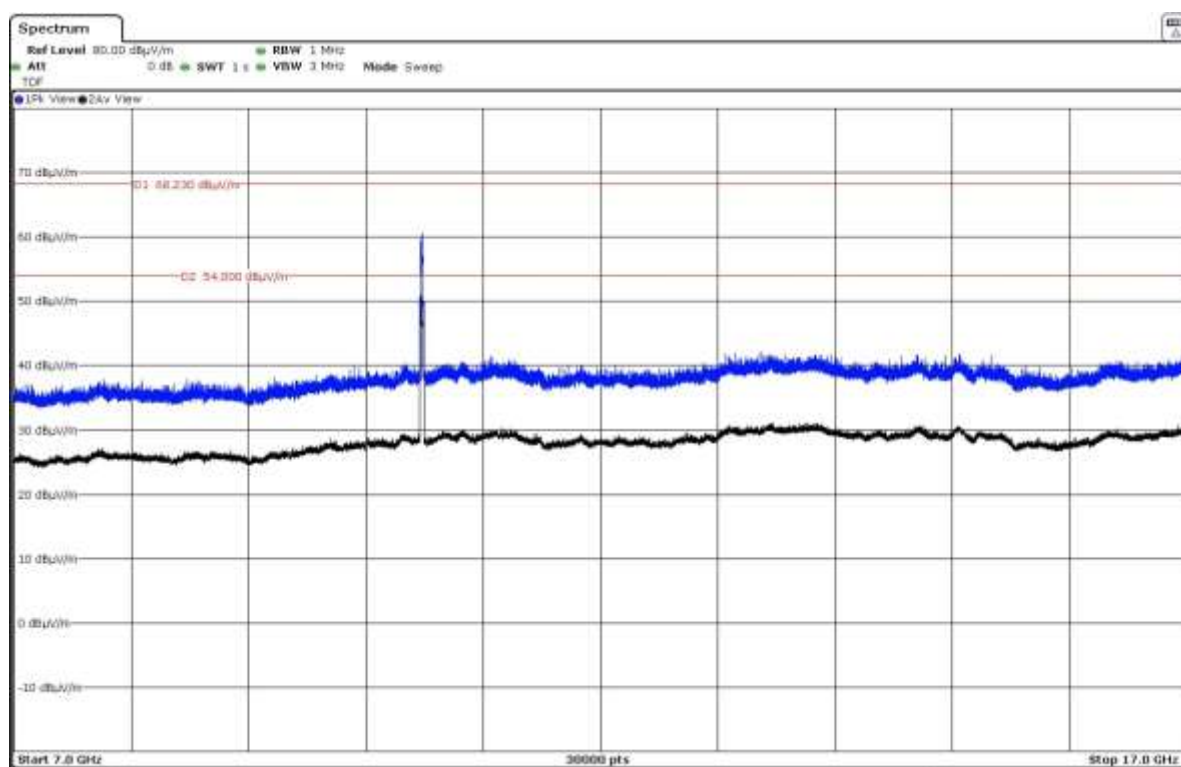
- Low Channel:



- Middle Channel:

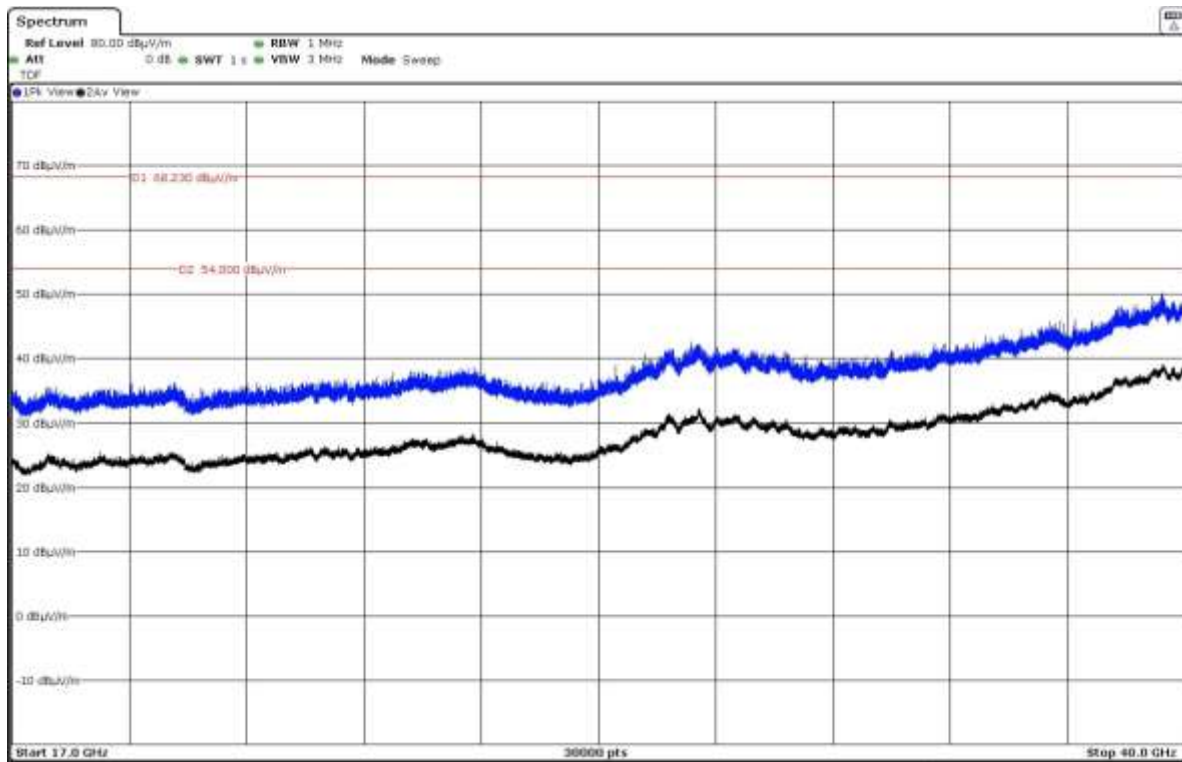


- High Channel:



FREQUENCY RANGE 17 - 40 GHz

This plot is valid for all the modulation modes and the Low, Middle and High Channels.



FCC 15.407 (b)(1) / RSS-247 6.2.1.2. Transmitter Band Edge Radiated Emissions.

SPECIFICATION:

For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz (68.23 dBμV/m at 3 m distance).

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 (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
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 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.

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

All emissions outside of the 5.15-5.35GHz band shall not exceed an EIRP of -27dBm/MHz. There are restricted bands of operation below band edge at 4.5-5.15 GHz also above the upper band edge at 5.35-5.46GHz therefore the provision of FCC Part 15.205 apply.

Field strength measurements using peak and average detector performed in the restricted bands below 5.15GHz and above 5.35 GHz.

Test performed on the following worst cases modes in all relevant tests channels:

- 802.11a: 6 Mbit/s.
- 802.11n HT20: MCS0.
- 802.11ac VHT20: MCS0.
- 802.11n HT40: MCS0.
- 802.11ac VHT40: MCS0.
- 802.11ac VHT80: MCS0.

• **802.11 a20:**

- Channel 36 (5180 MHz): Inside band spurious emissions in 4.50-5.15 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.14708	57.61	74	H	Peak	<±4.11
	44.81	54		Average	<±4.11

- Channel 48 (5240 MHz): Inside band spurious emissions in 5.35-5.46 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.439302	56.99	74	V	Peak	<±4.11
	43.92	54		Average	<±4.11

• **802.11 n20:**

- Channel 36 (5180 MHz): Inside band spurious emissions in 4.50-5.15 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.11609	56.02	74	V	Peak	<±4.11
	44.55	54		Average	<±4.11

- Channel 48 (5240 MHz): Inside band spurious emissions in 5.35-5.46 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.431968	55.94	74	V	Peak	<±4.11
	43.92	54		Average	<±4.11

• **802.11 ac20:**

- Channel 36 (5180 MHz): Inside band spurious emissions in 4.50-5.15 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.14946	56.20	74	V	Peak	<±4.11
	45.03	54		Average	<±4.11

- Channel 48 (5240 MHz): Inside band spurious emissions in 5.35-5.46 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.385182	56.28	74	H	Peak	<±4.11
	43.55	54		Average	<±4.11

• **802.11 n40:**

- Channel 38 (5190 MHz): Inside band spurious emissions in 4.50-5.15 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.14599	60.26	74	H	Peak	<±4.11
	45.55	54		Average	<±4.11

- Channel 46 (5230 MHz): Inside band spurious emissions in 5.35-5.46 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.373522	56.13	74	H	Peak	<±4.11
	44.07	54		Average	<±4.11

• **802.11 ac40:**

- Channel 38 (5190 MHz): Inside band spurious emissions in 4.50-5.15 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.14989	62.13	74	H	Peak	<±4.11
	47.29	54		Average	<±4.11

- Channel 46 (5230 MHz): Inside band spurious emissions in 5.35-5.46 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.450705	56.01	74	H	Peak	<±4.11
	43.7	54		Average	<±4.11

• **802.11 ac80:**

- Channel 42 (5210 MHz): Inside band spurious emissions in 4.50-5.15 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.14664	60.7	74	H	Peak	<±4.11
	45.5	54		Average	<±4.11

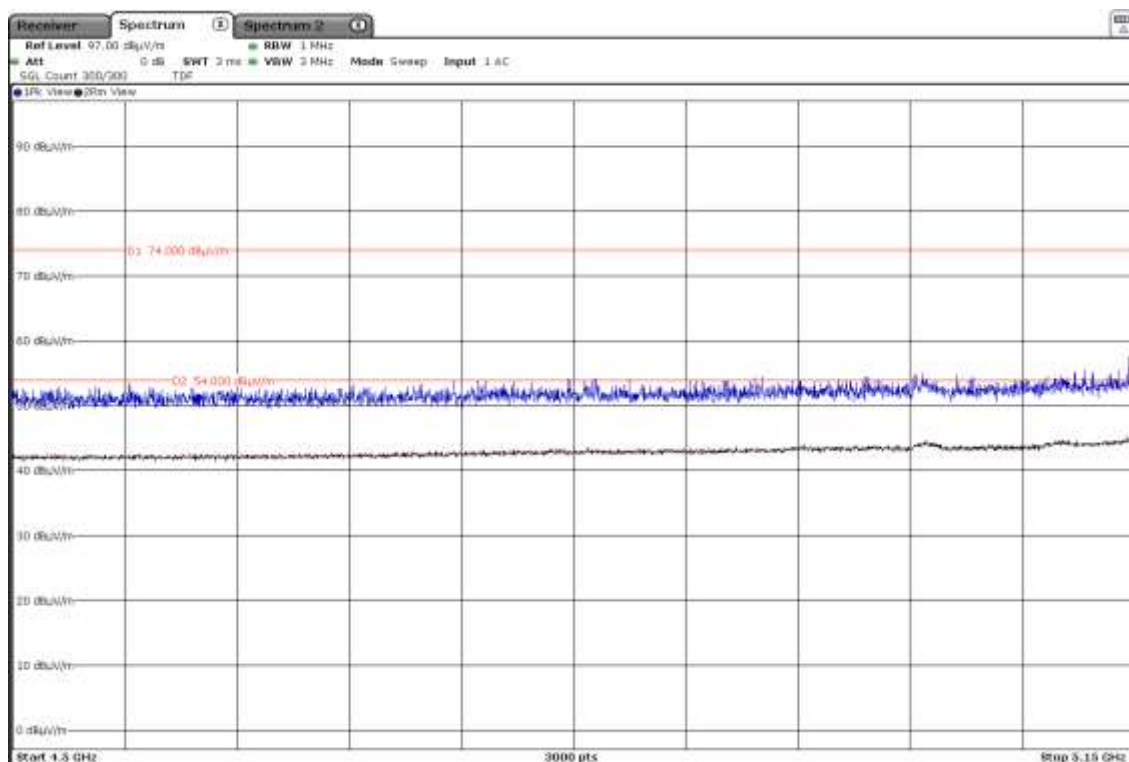
- Channel 42 (5210 MHz): Inside band spurious emissions in 5.35-5.46 GHz adjacent band.

Spurious frequency (GHz)	Emission Level (dBμV/m)	Limit (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.357975	56.21	74	H	Peak	<±4.11
	43.69	54		Average	<±4.11

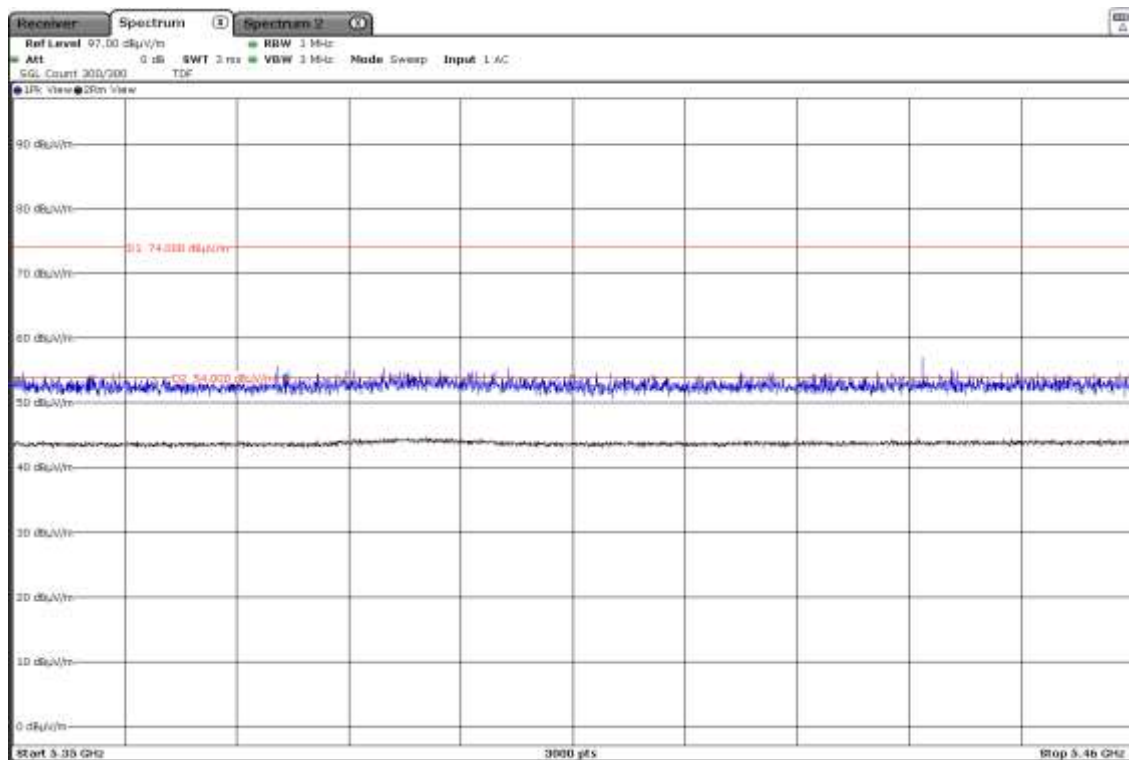
Verdict: PASS

- **802.11 a20:**

- Lower Band Edge Channel 36 (4.50-5.15 GHz)

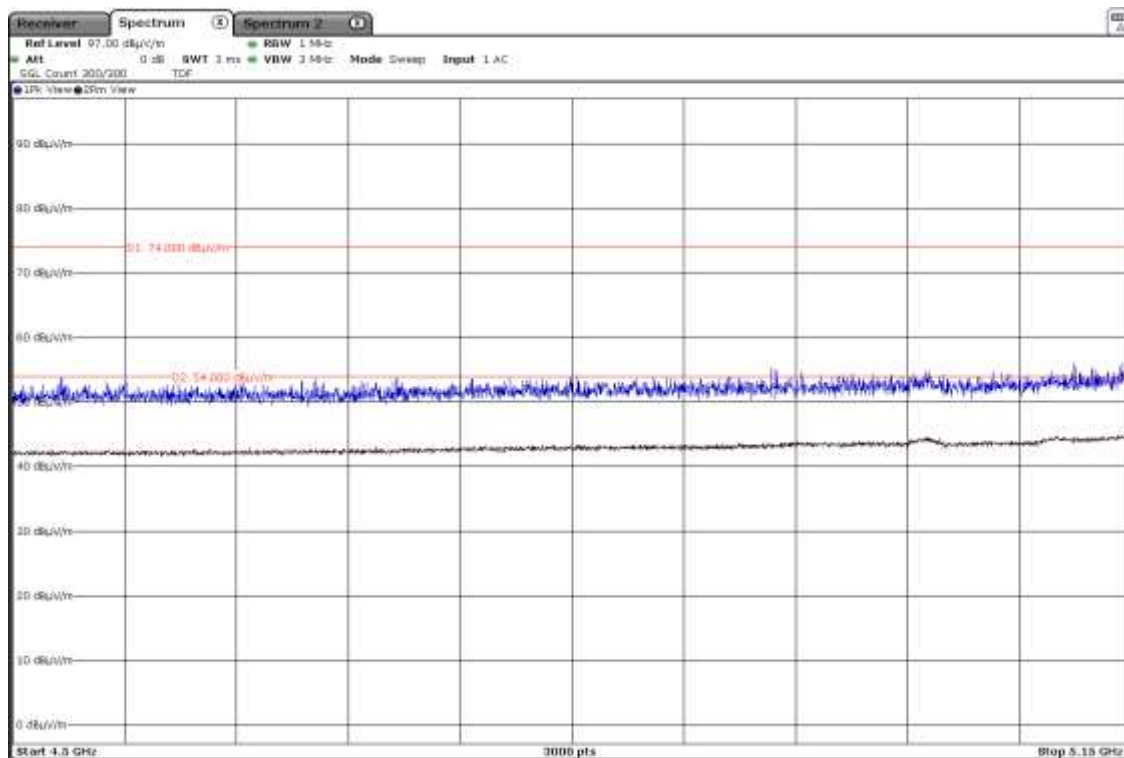


- Upper Band Edge Channel 48 (5.35-5.46 GHz)

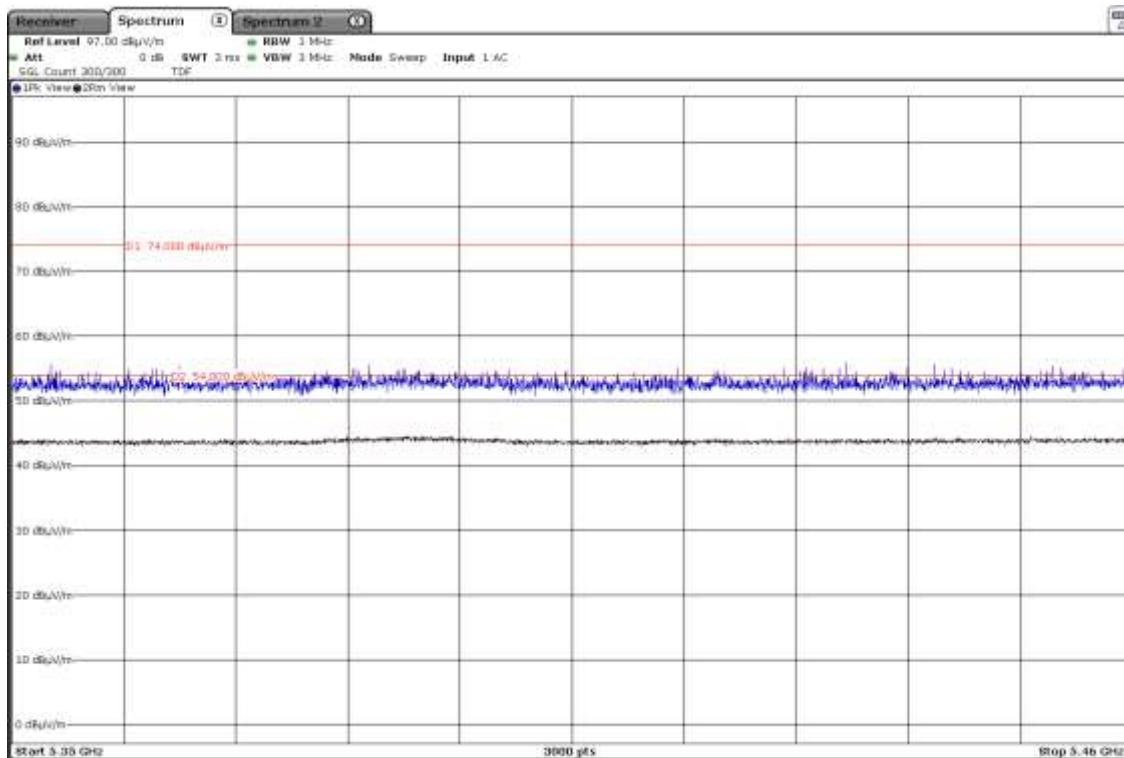


- 802.11 n20:

- Lower Band Edge Channel 36 (4.50-5.15 GHz)

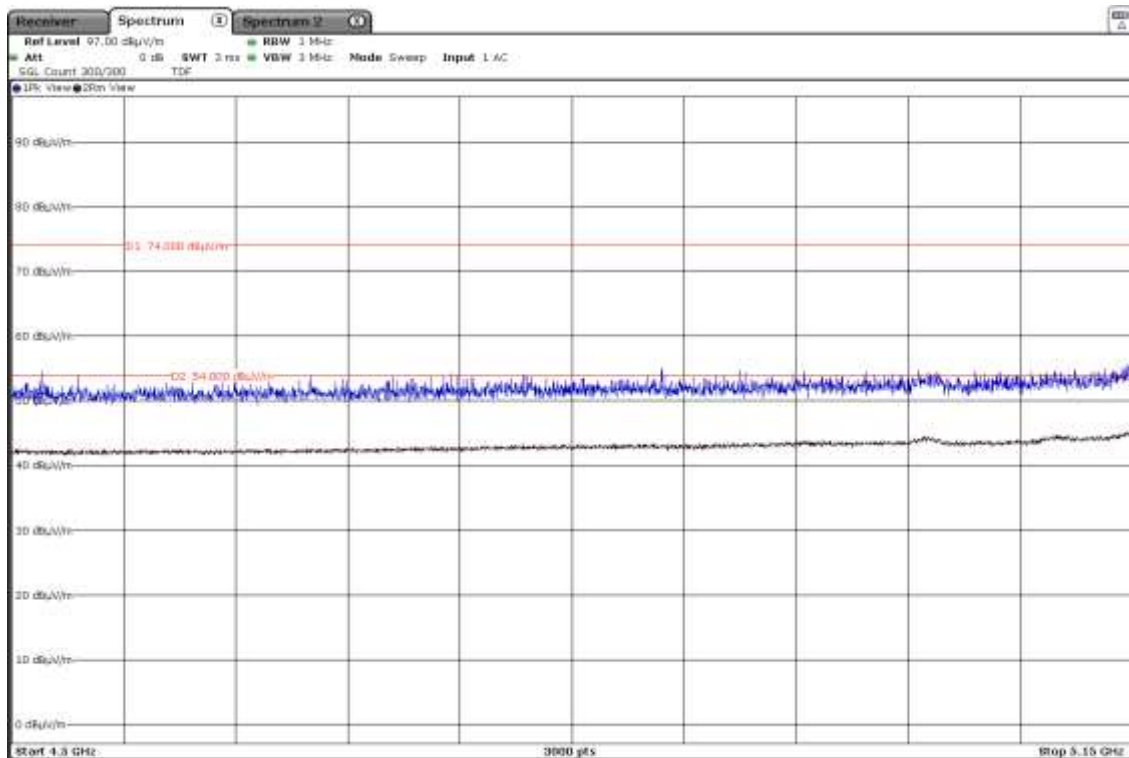


- Upper Band Edge Channel 48 (5.35-5.46 GHz)

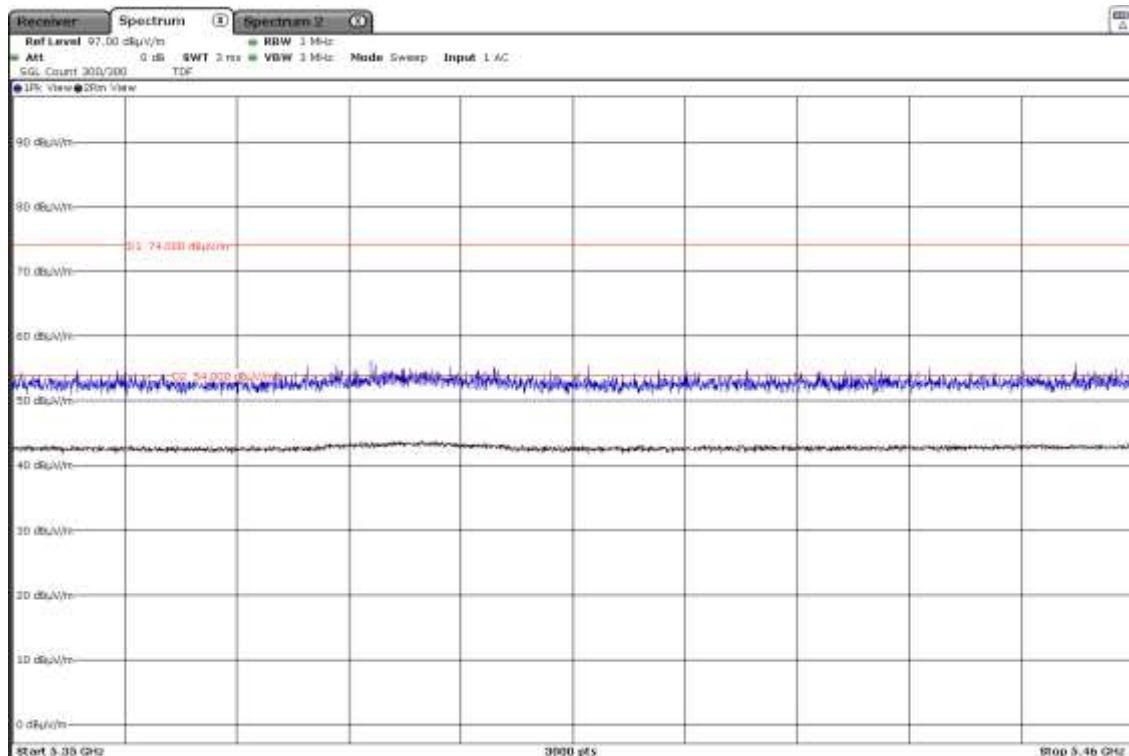


- **802.11 ac20:**

- Lower Band Edge Channel 36 (4.50-5.15 GHz)

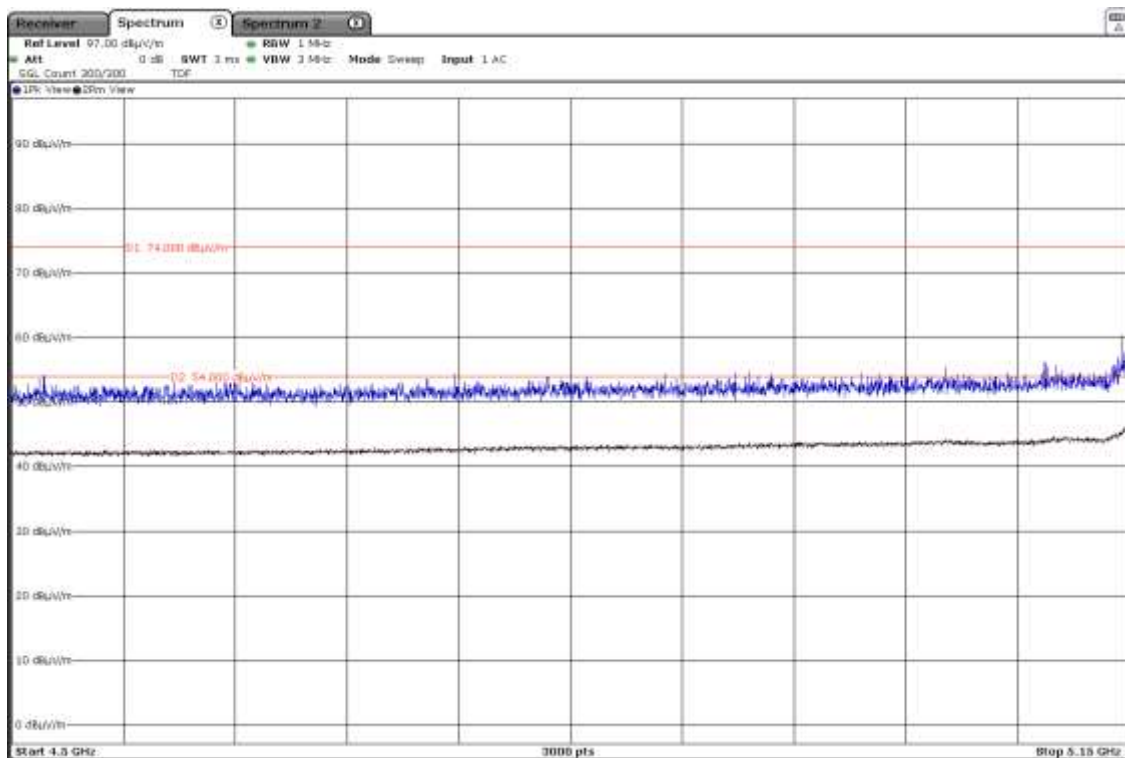


- Upper Band Edge Channel 48 (5.35-5.46 GHz)

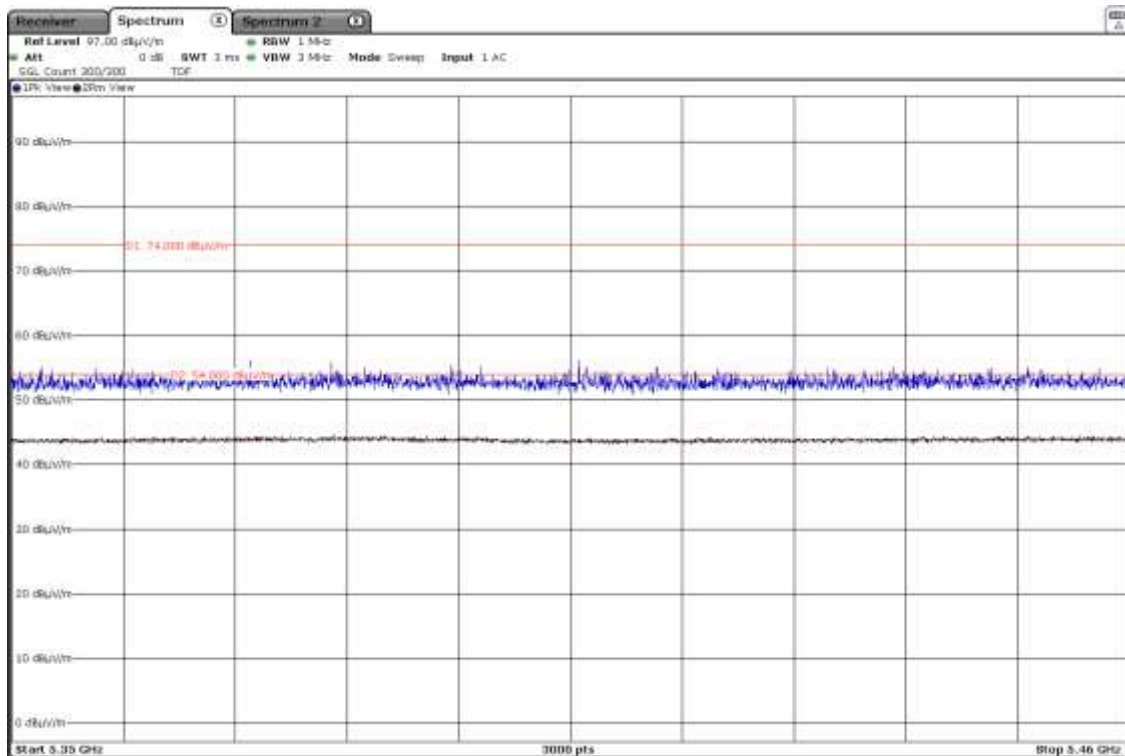


- 802.11 n40:

- Lower Band Edge Channel 38 (4.50-5.15 GHz)

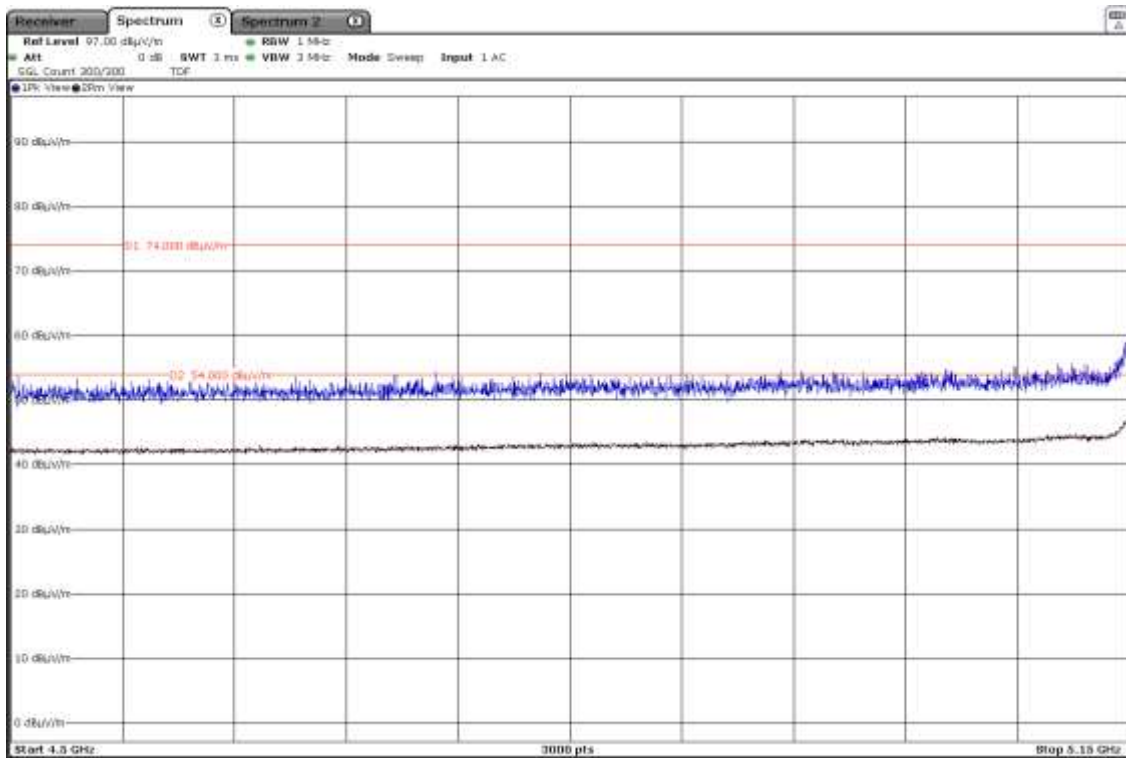


- Upper Band Edge Channel 46 (5.35-5.46 GHz)

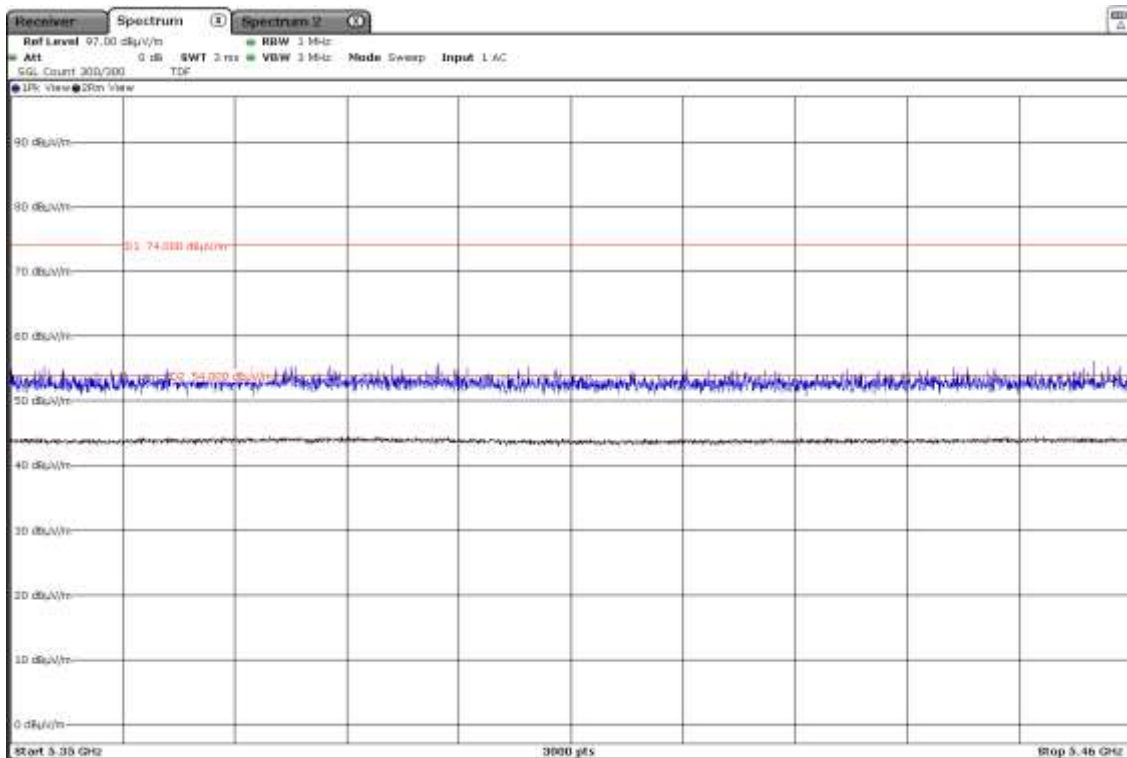


- **802.11 ac40:**

- Lower Band Edge Channel 38 (4.50-5.15 GHz)

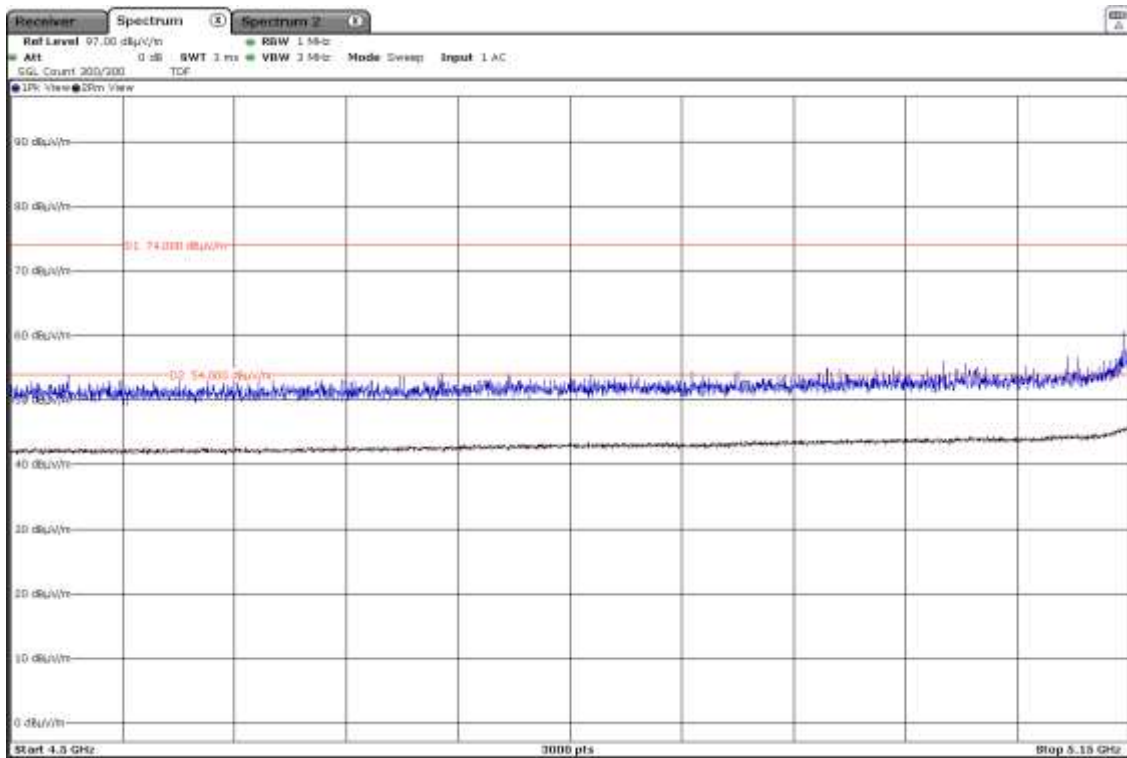


- Upper Band Edge Channel 46 (5.35-5.46 GHz)

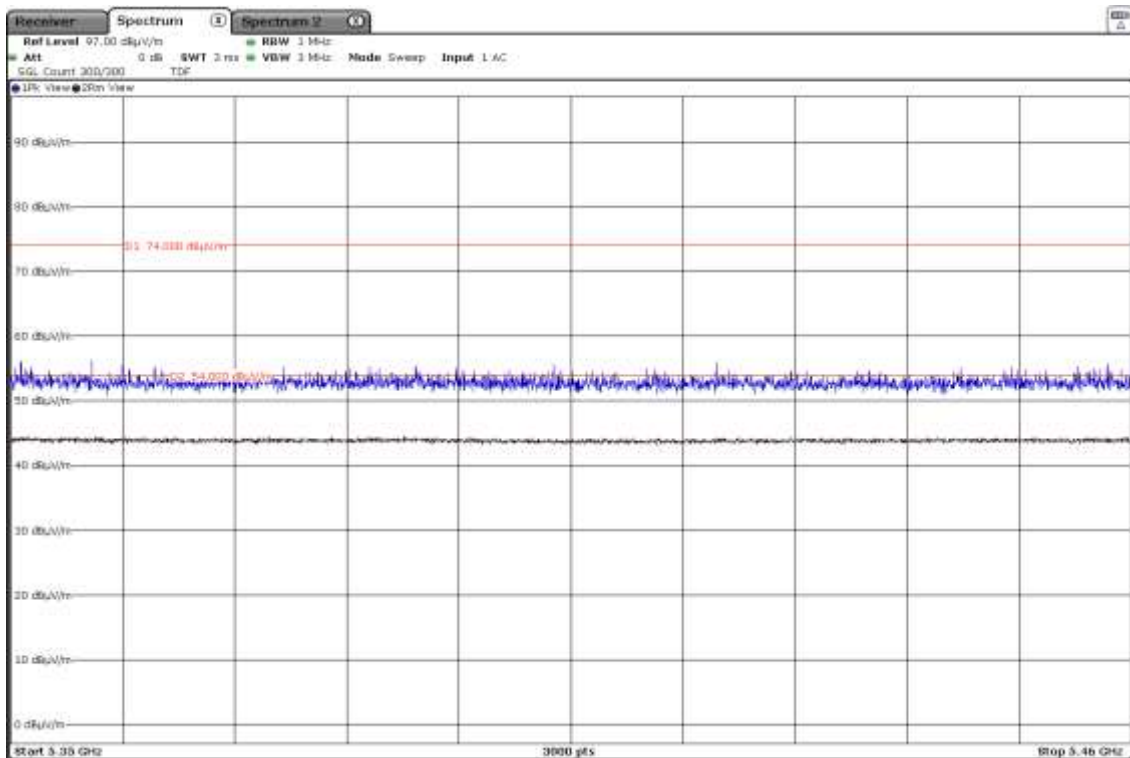


- **802.11 ac80:**

- Lower Band Edge Channel 42 (4.50-5.15 GHz)



- Upper Band Edge Channel 42 (5.35-5.46 GHz)



Appendix B: Tests results for the U-NII-3 Band 5.725 – 5.85 GHz

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TEST CONDITIONS	33
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TEST CONDITIONS

POWER SUPPLY (V):

Vnominal: 12 Vdc
Type of Power Supply: External DC (Vehicle battery).

ANTENNA:

Type of Antenna: External.
Maximum Declared Assembly Antenna Gain: +2.5 dBi

TEST FREQUENCIES:

Technology Tested:	WLAN (IEEE 802.11 a/n/ac): U-NII-3 band	
Modes:	802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps	
	802.11n HT20: MCS0 to MCS7	
	802.11n HT40: MCS0 to MCS7	
	802.11ac VHT20: MCS0 to MCS8	
	802.11ac VHT40: MCS0 to MCS9	
	802.11ac VHT80: MCS0 to MCS9	
Setting of cores / ports:	One port.	
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 FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

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:

- 802.11a20: 6 Mbits
- 802.11n HT20: MCS0
- 802.11n HT40: MCS0
- 802.11ac VHT20: MCS0
- 802.11ac VHT40: MCS0
- 802.11ac VHT80: MCS0

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).

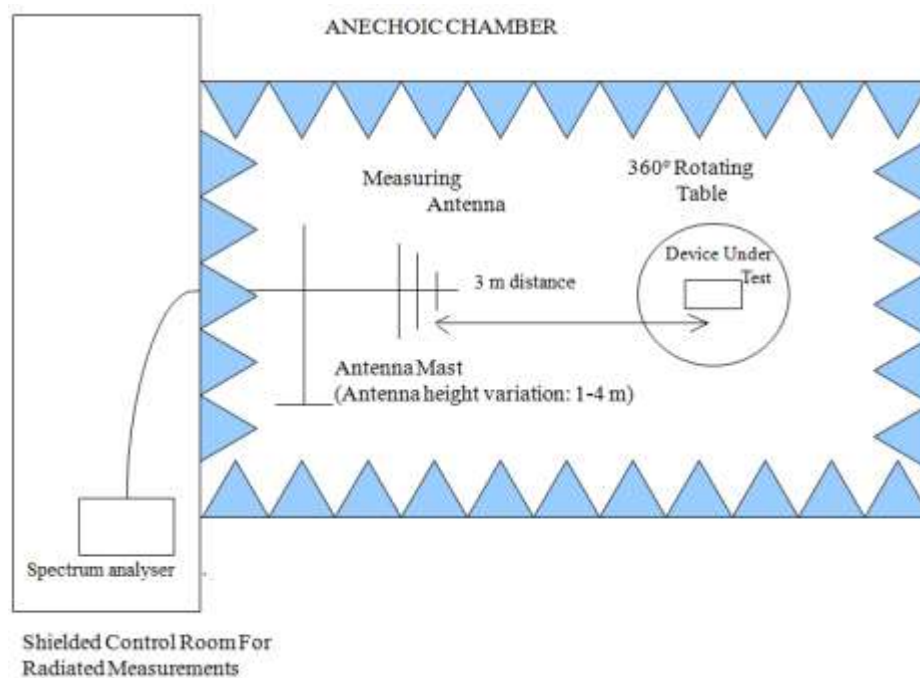
For radiated emissions in the range 1 GHz-40 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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.

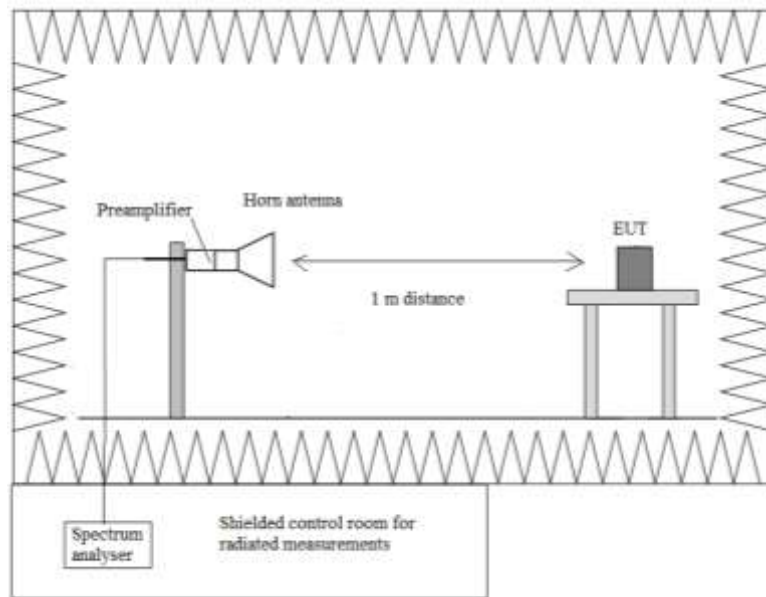
Measurements were made in both horizontal and vertical planes of polarization.

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

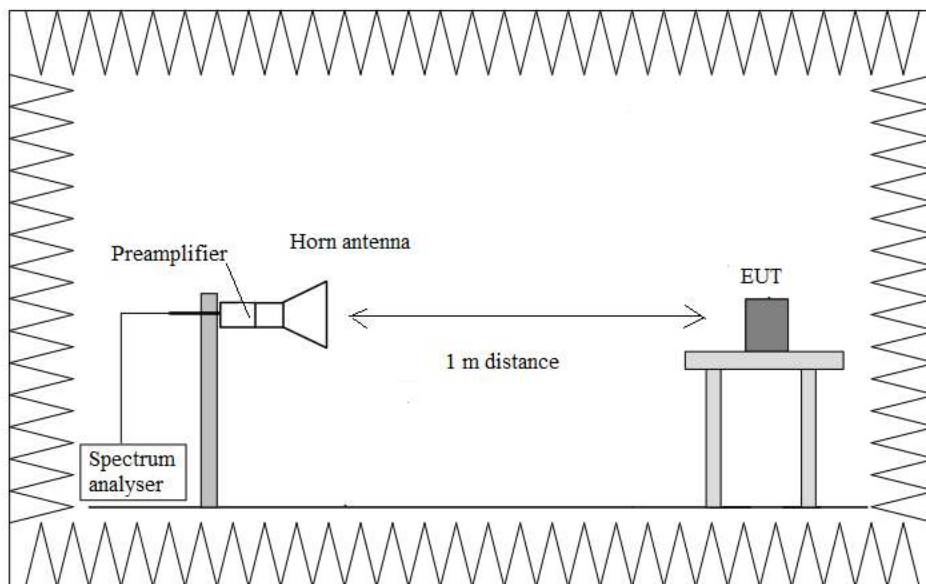
Radiated measurements setup $f < 1$ GHz



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



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



FCC 15.407 (b)(4)(6) / RSS-247 6.2.4.2. Transmitter Out of Band Radiated Emissions

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 dBμV/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 (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
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° 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.

All tests were performed in a semi-anechoic chamber at a distance of 1m for the frequency range 1 GHz-40 GHz and a distance of 3m for frequency range 30MHz-1GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum 36nalyser. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

- Test performed on the worst case: 802.11 ac20 (MSC0).

The worst case was determined by measuring the eirp density (radiated).

Frequency range 30 MHz – 1 GHz

The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

Spurious frequencies operating (radiated) at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
45.8270	34.8	V	Quasi-Peak	± 5.08
91.3530	32.9	V	Quasi-Peak	± 5.08
244.063	35.2	V	Quasi-Peak	± 5.08
274.553	27.6	V	Quasi-Peak	± 5.08
283.574	29.0	H	Quasi-Peak	± 5.08
375.013	35.0	H	Quasi-Peak	± 5.08
499.981	35.8	H	Quasi-Peak	± 5.08
958.339	35.7	V	Quasi-Peak	± 5.08

Frequency range 1 - 40 GHz

The results in the next tables show the maximum measured levels in the 1-40 GHz range except the 5.65-5.725 GHz and 5.85-5.925GHz adjacent bands. The results in the adjacent bands was evaluated on the next section.

The Low, Middle and High Channels were measured for out-of-band emissions for the worst mode.

Spurious frequencies with peak levels above the average limit (54 dBμV/m at 3 m) are measured with an average detector for checking compliance with the average limit.

- **802.11 ac20 (worst case):**

- LOW CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.61240	51.07	V	Peak	<±4.11
11.48450	56.97	H	Peak	<±5.13
	46.25		Average	<±5.13
39.58408	51.18	V	Peak	<±5.14

- MIDDLE CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.63330	52.17	V	Peak	<±4.11
11.57217	55.45	H	Peak	<±5.13
	45.04		Average	<±5.13
39.52658	49.67	H	Peak	<±5.14

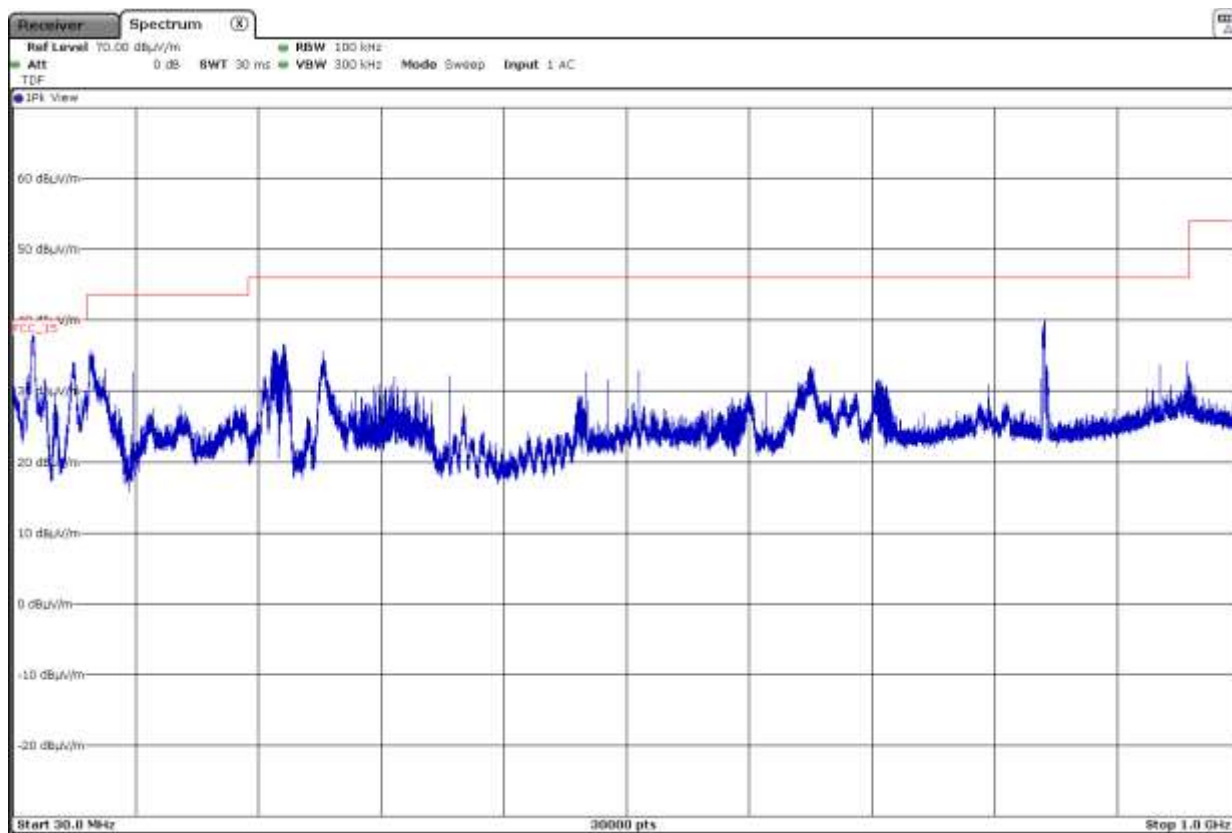
- HIGH CHANNEL. Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5.678487	50.01	V	Peak	<±4.11
11.65183	56.27	H	Peak	<±5.13
	45.95		Average	<±5.13
39.55265	49.73	H	Peak	<±5.14

Verdict: PASS

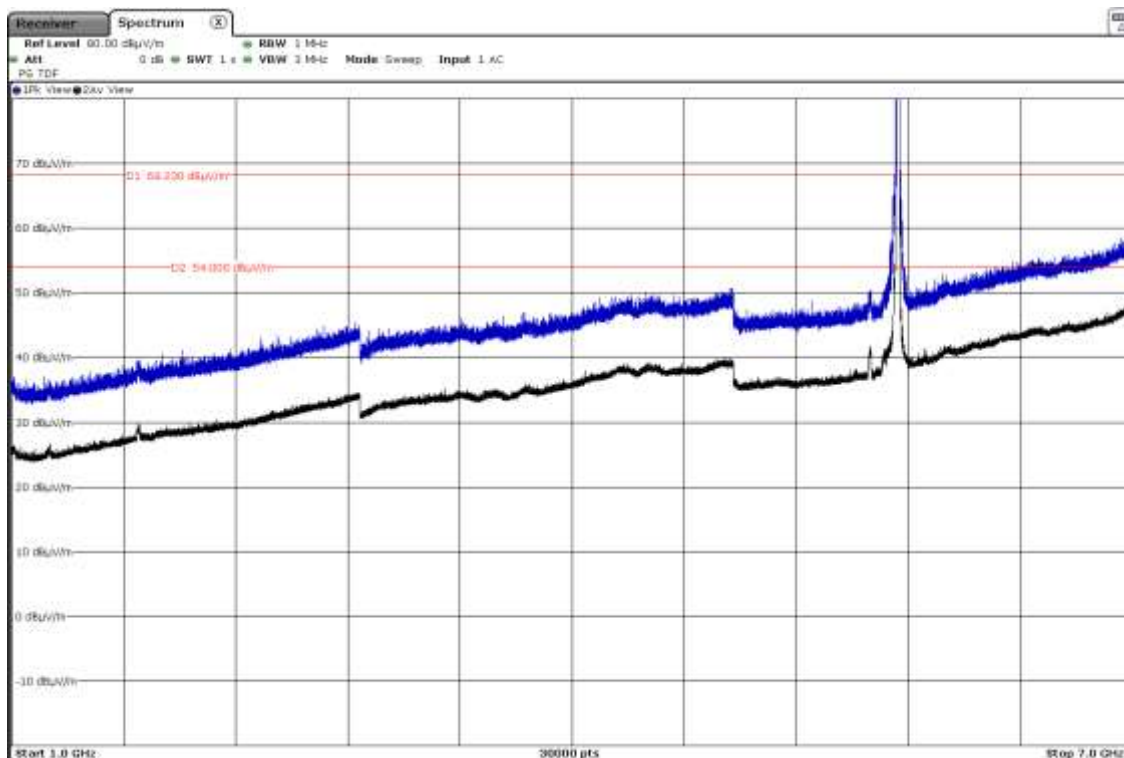
FREQUENCY RANGE 30 MHz - 1 GHz

This plot is valid for all the modulation modes and the Low, Middle and High Channels.



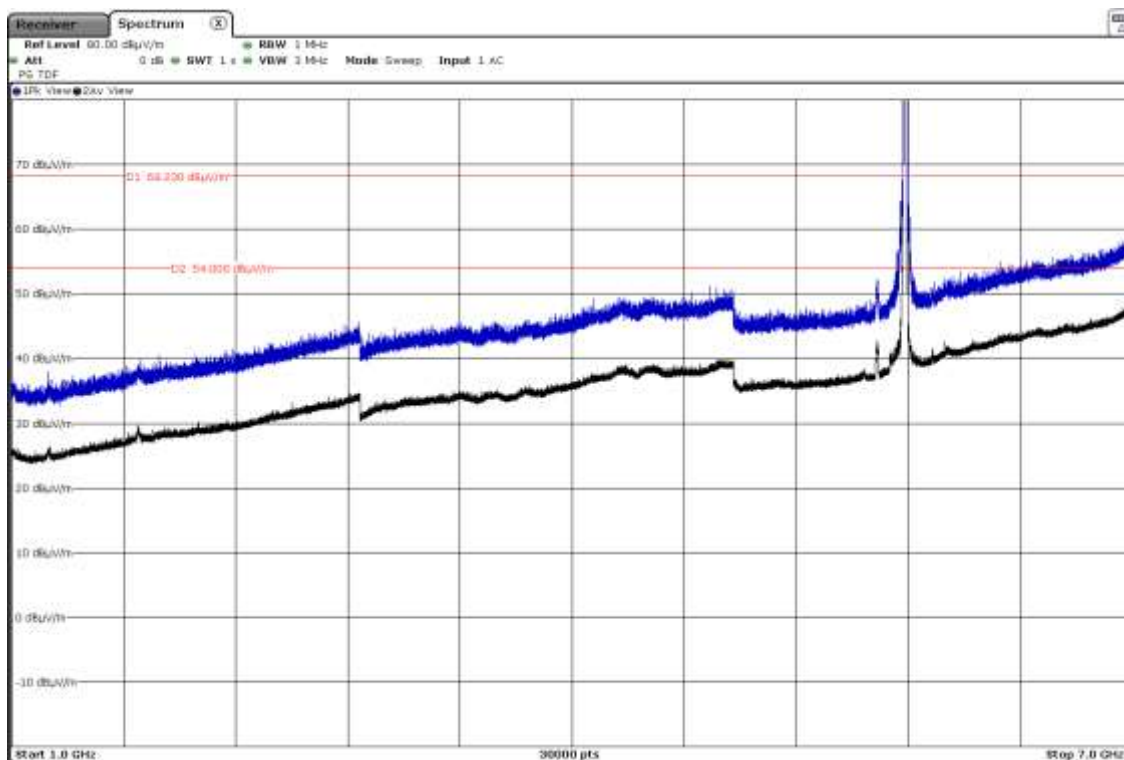
REQUENCY RANGE 1 – 7 GHz (worst case)

- Low Channel:



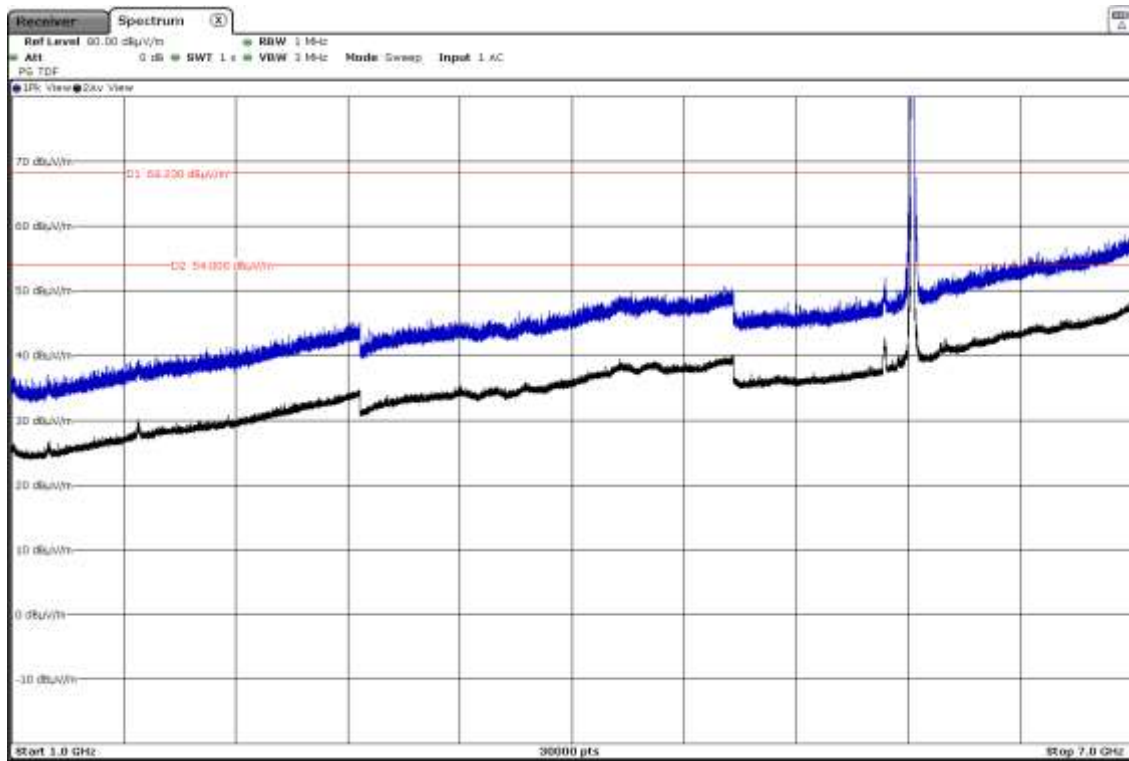
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

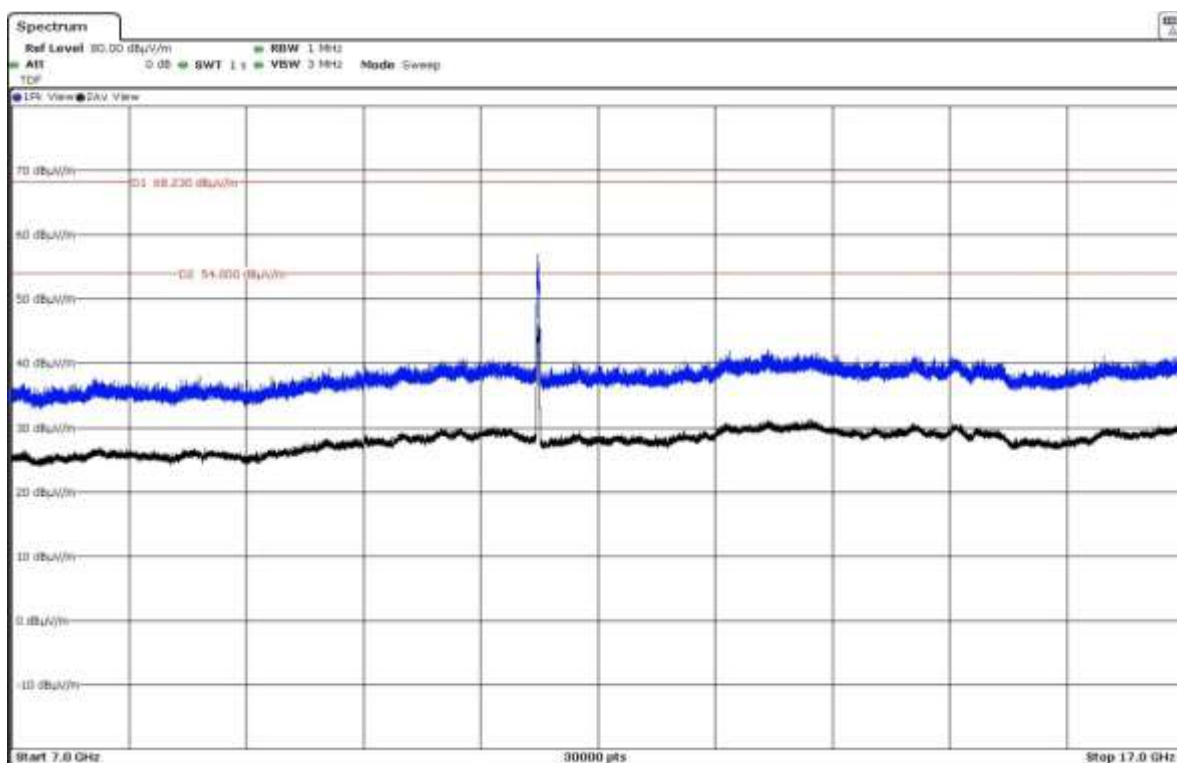
- High Channel:



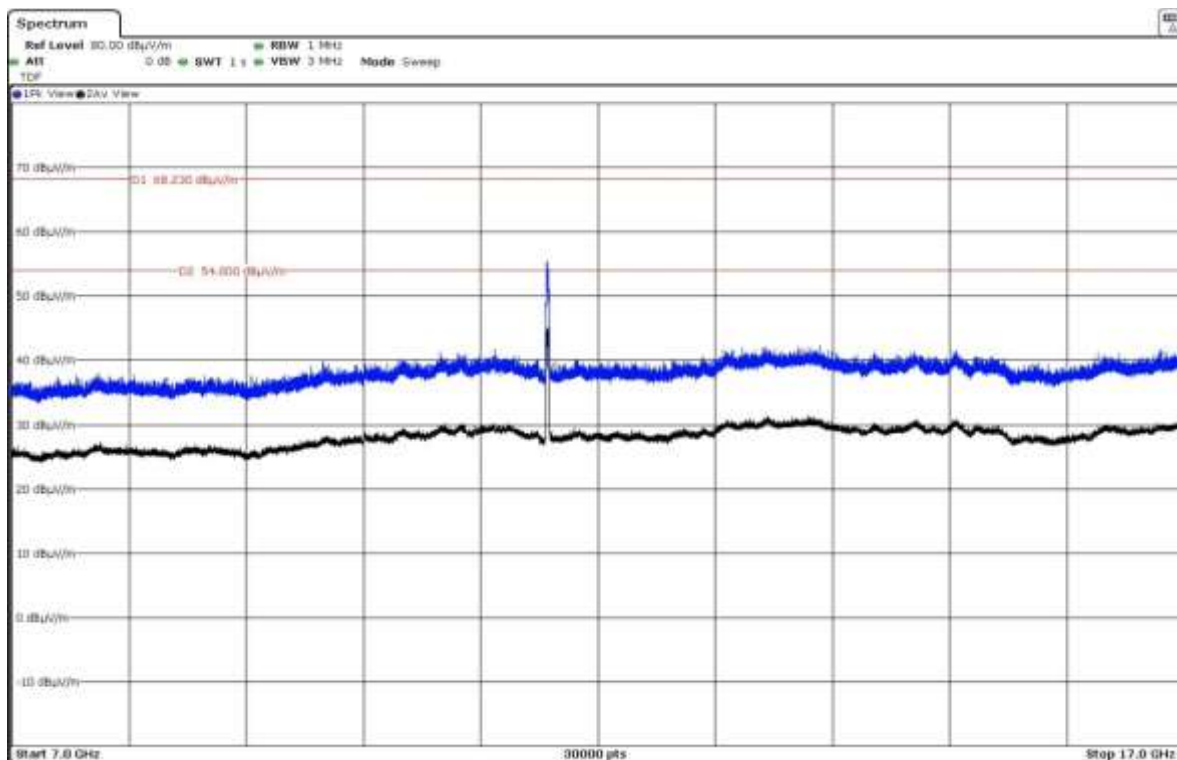
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 7 - 17 GHz (worst case)

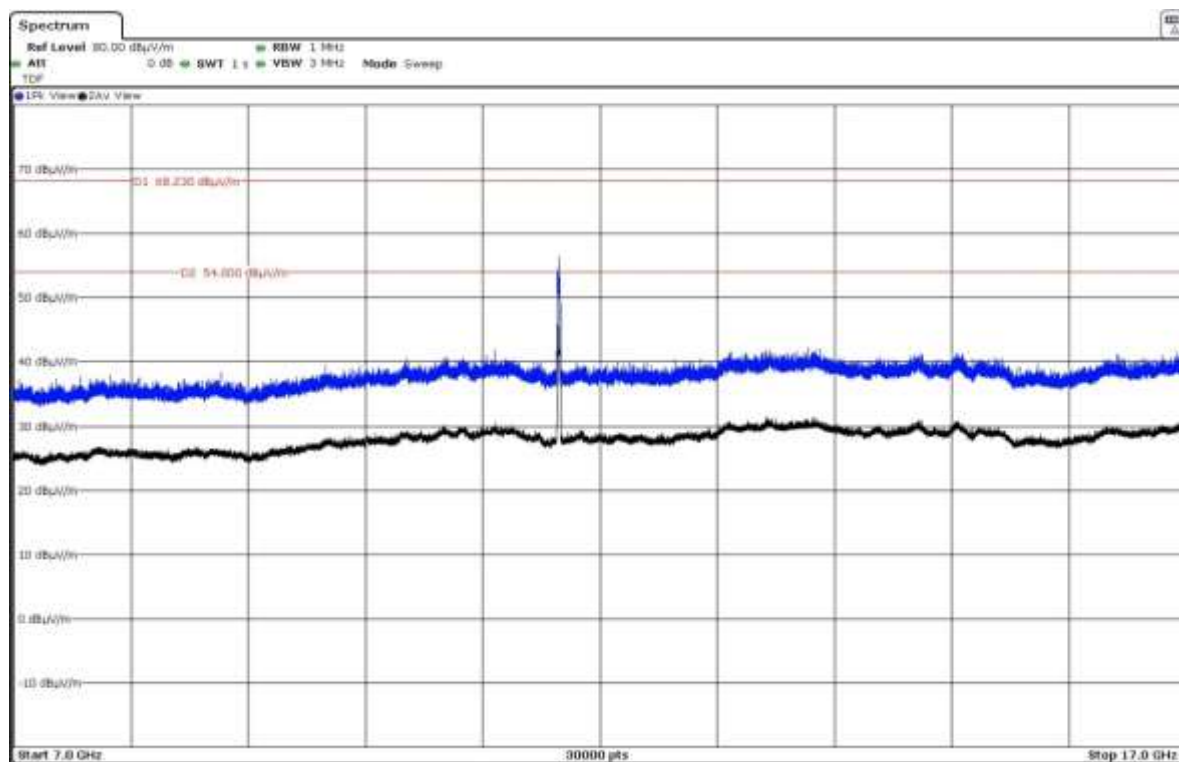
- Low Channel:



- Middle Channel:

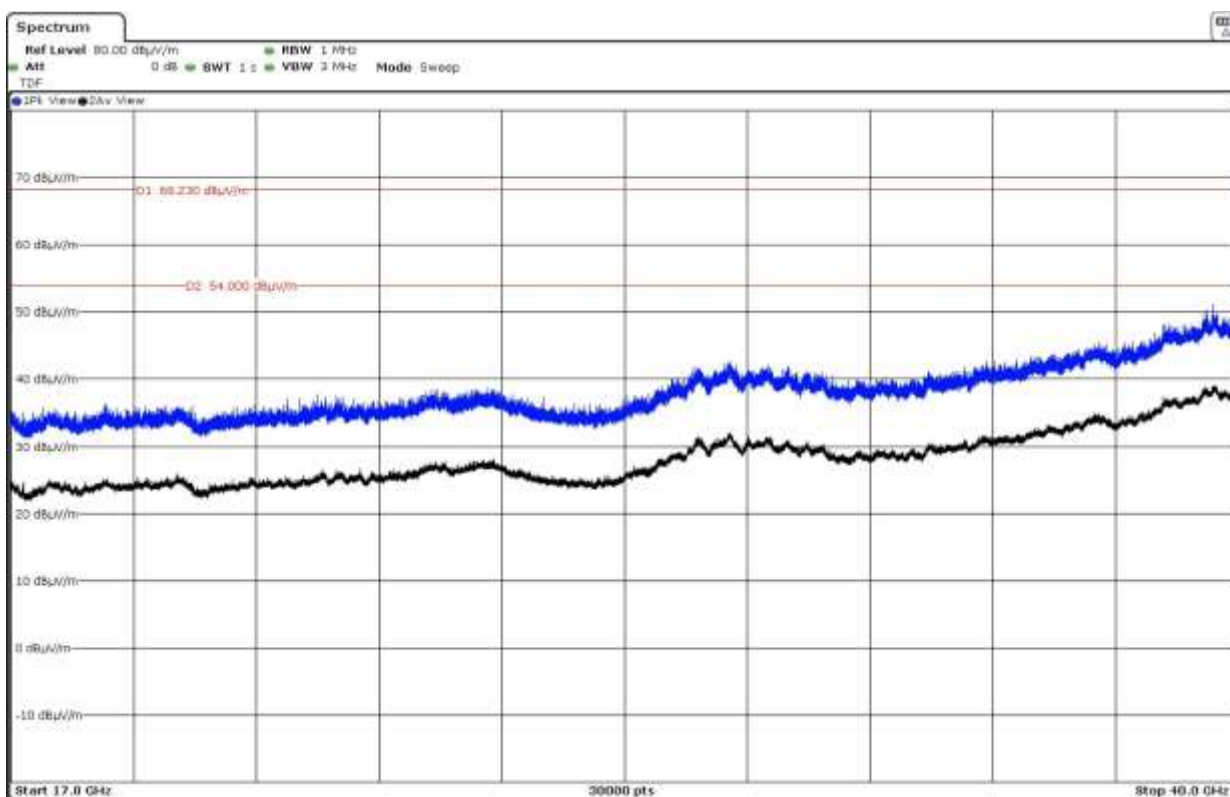


- High Channel:



FREQUENCY RANGE 17 - 40 GHz

This plot is valid for all the modulation modes and the Low, Middle and High Channels.



FCC 15.407 (b)(4) / RSS-247 6.2.4.2. Transmitter Band Edge Radiated Emissions.

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 dBμV/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 (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
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 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.

Test performed on the following worst cases modes in all relevant tests channels:

- 802.11a20: 6 Mbits
- 802.11n HT20: MCS0
- 802.11n HT40: MCS0
- 802.11ac VHT40: MCS0
- 802.11ac VHT80: MCS0

- **802.11 a20:**

Inside band spurious emissions in 5.65-5.925 GHz adjacent band.

- Lower Channel 149 (5745 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- Middle Channel 157 (5785 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- High Channel 165 (5825 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

The measurement uncertainty (dB) is $<\pm 4.11$

- **802.11 n20:**

Inside band spurious emissions in 5.65-5.925 GHz adjacent band.

- Low Channel 149 (5745 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- Middle Channel 157 (5785 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- High Channel 165 (5825 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

The measurement uncertainty (dB) is $<\pm 4.11$

- **802.11 ac20:**

Inside band spurious emissions in 5.65-5.925 GHz adjacent band.

- Low Channel 149 (5745 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- Middle Channel 157 (5785 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- High Channel 165 (5825 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

The measurement uncertainty (dB) is $<\pm 4.11$

- **802.11 n40:**

Inside band spurious emissions in 5.65-5.925 GHz adjacent band.

- Low Channel 151 (5755 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- High Channel 159 (5795 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

The measurement uncertainty (dB) is $<\pm 4.11$

- **802.11 ac40:**

Inside band spurious emissions in 5.65-5.925 GHz adjacent band.

- Low Channel 151 (5755 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

- High Channel 159 (5795 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

The measurement uncertainty (dB) is $<\pm 4.11$

- **802.11 ac80:**

Inside band spurious emissions in 5.65-5.925 GHz adjacent band.

- Middle Channel 155 (5775 MHz):

No radiated spurious frequencies detected at less than 20 dB below the limit.

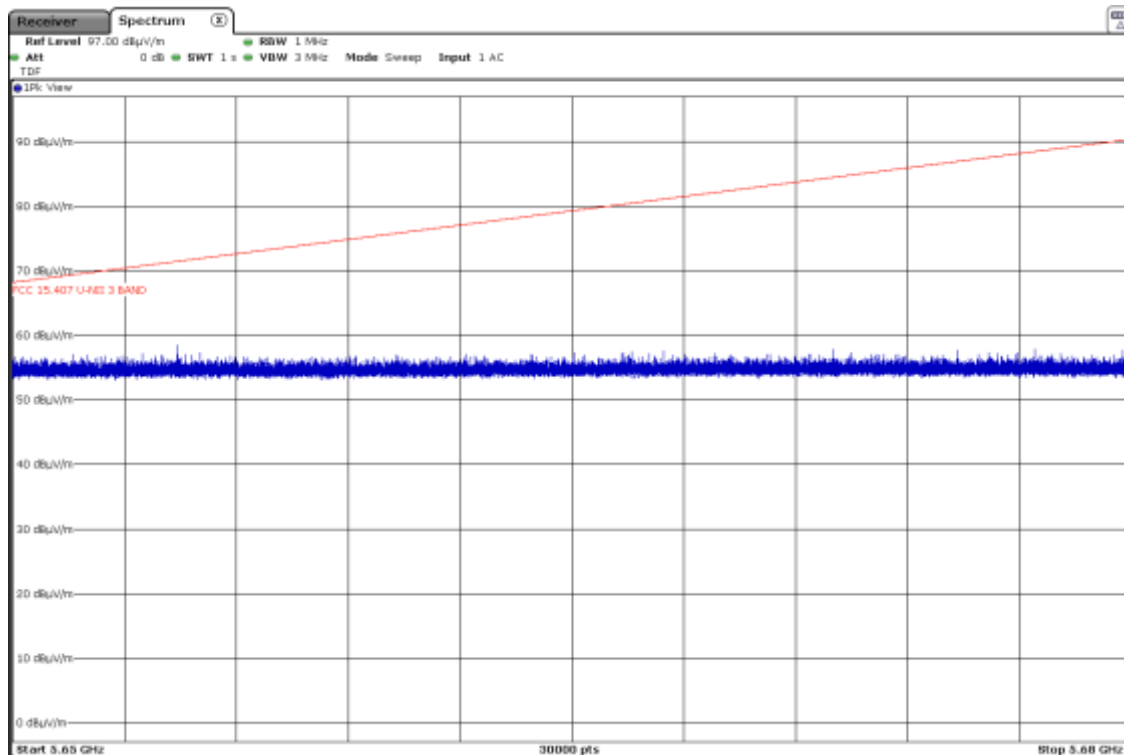
The measurement uncertainty (dB) is $<\pm 4.11$

Verdict: PASS

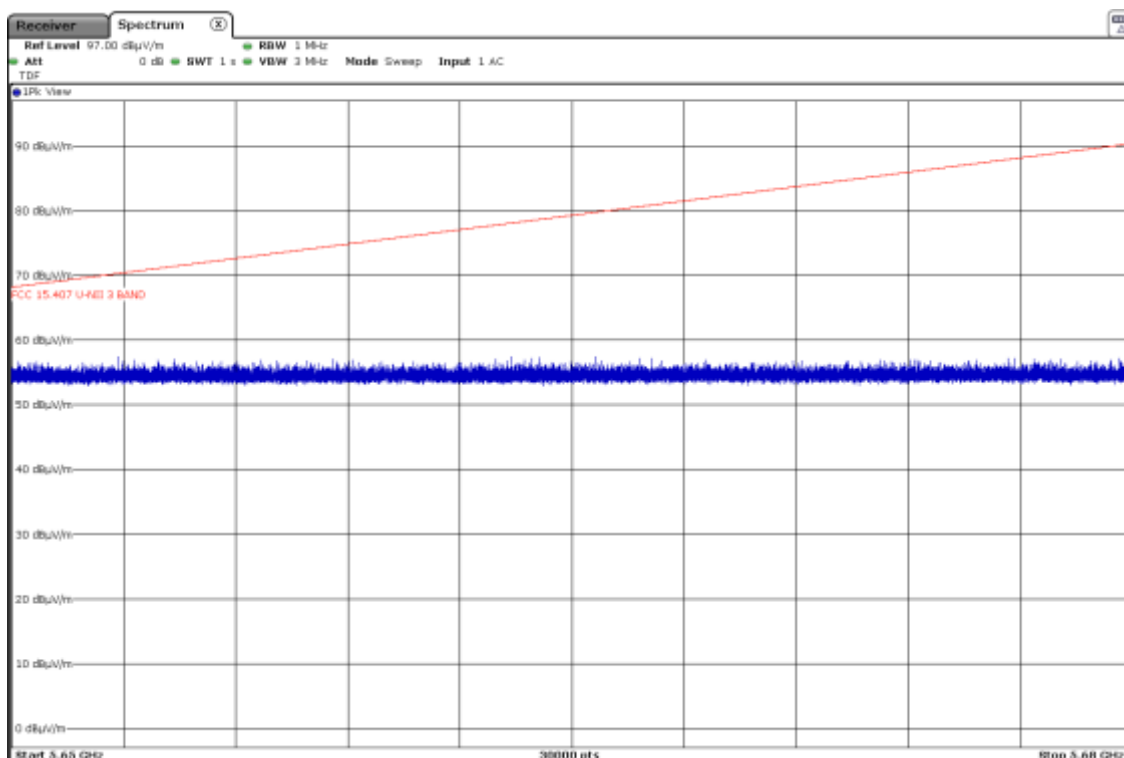
- 802.11 a20:

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

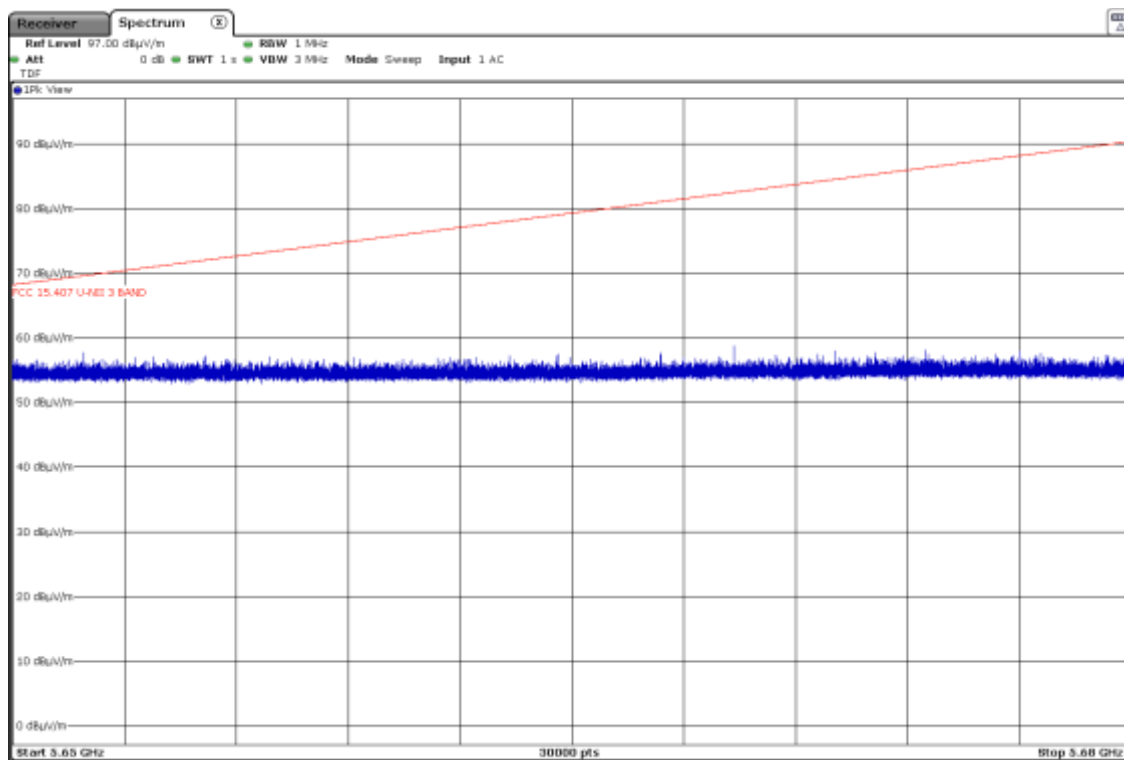
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):

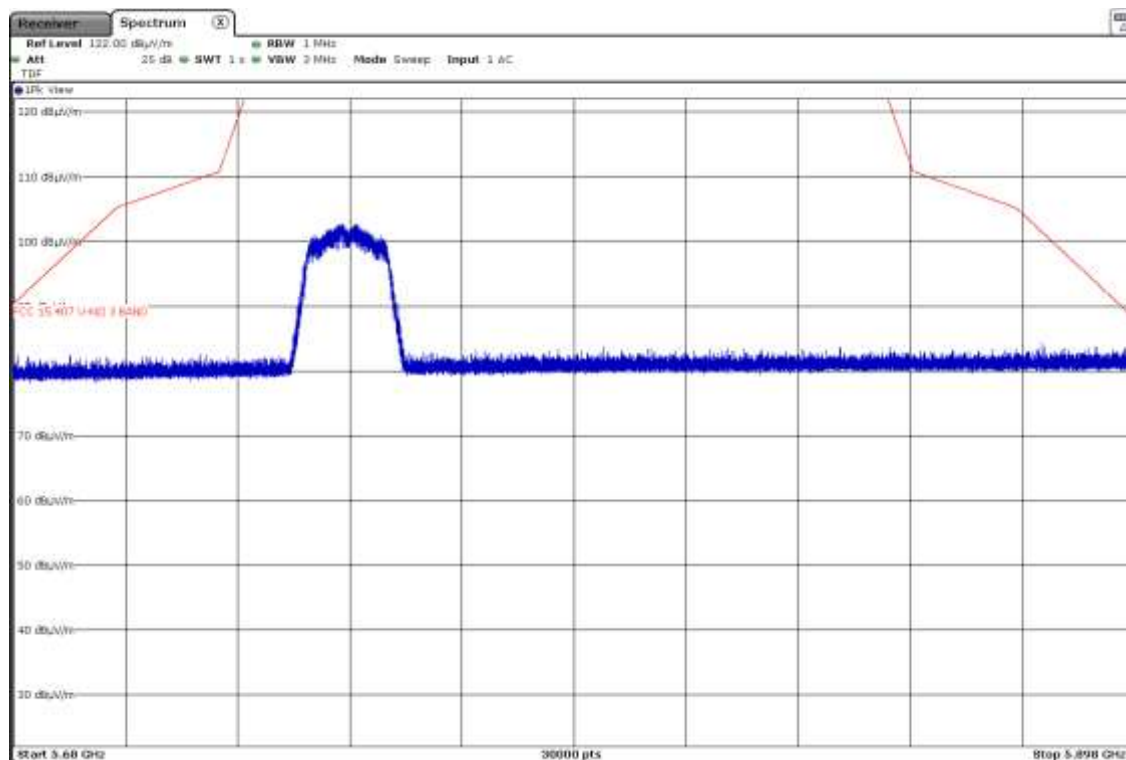


- High Channel 165 (5825 MHz):

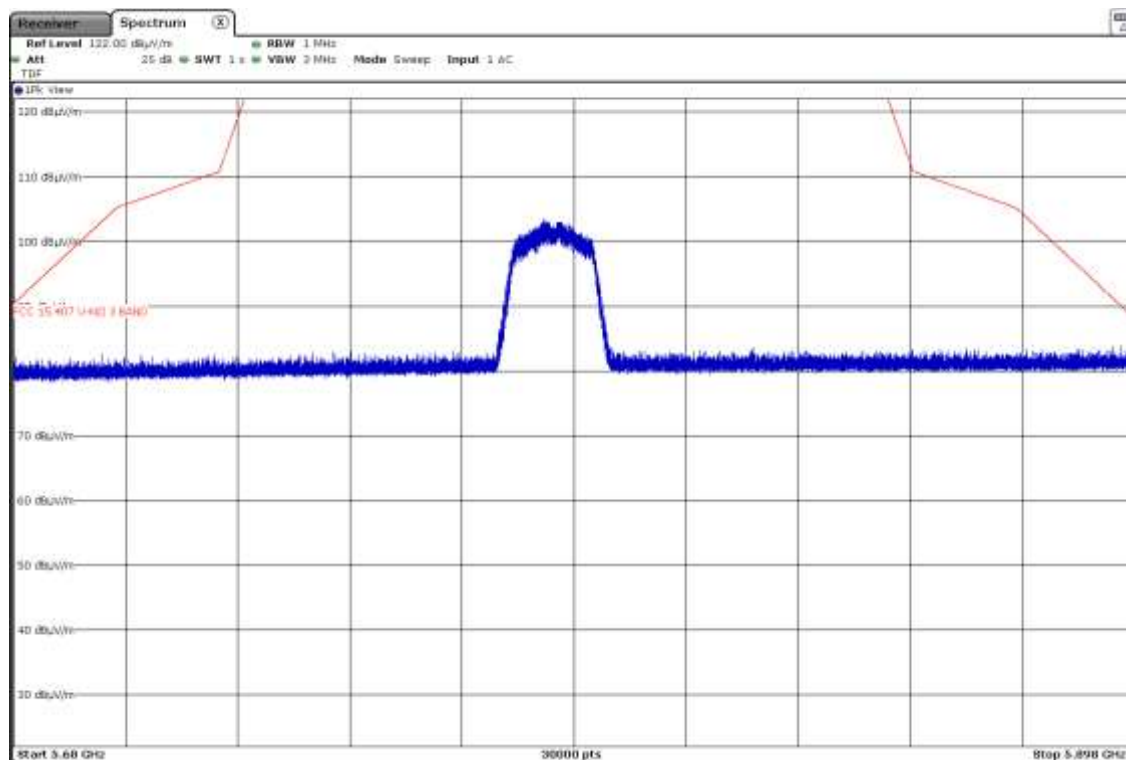


Radiated spurious emissions at band-edges and inside adjacent band 5.68 – 5.898 GHz

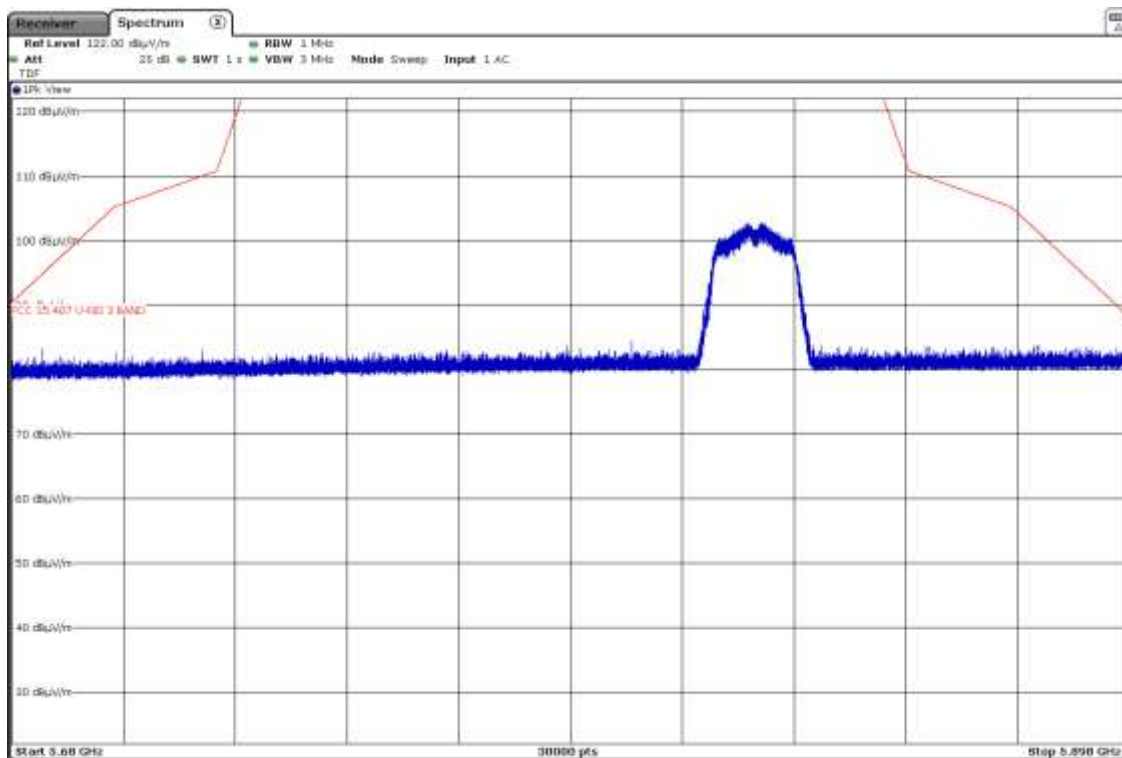
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):

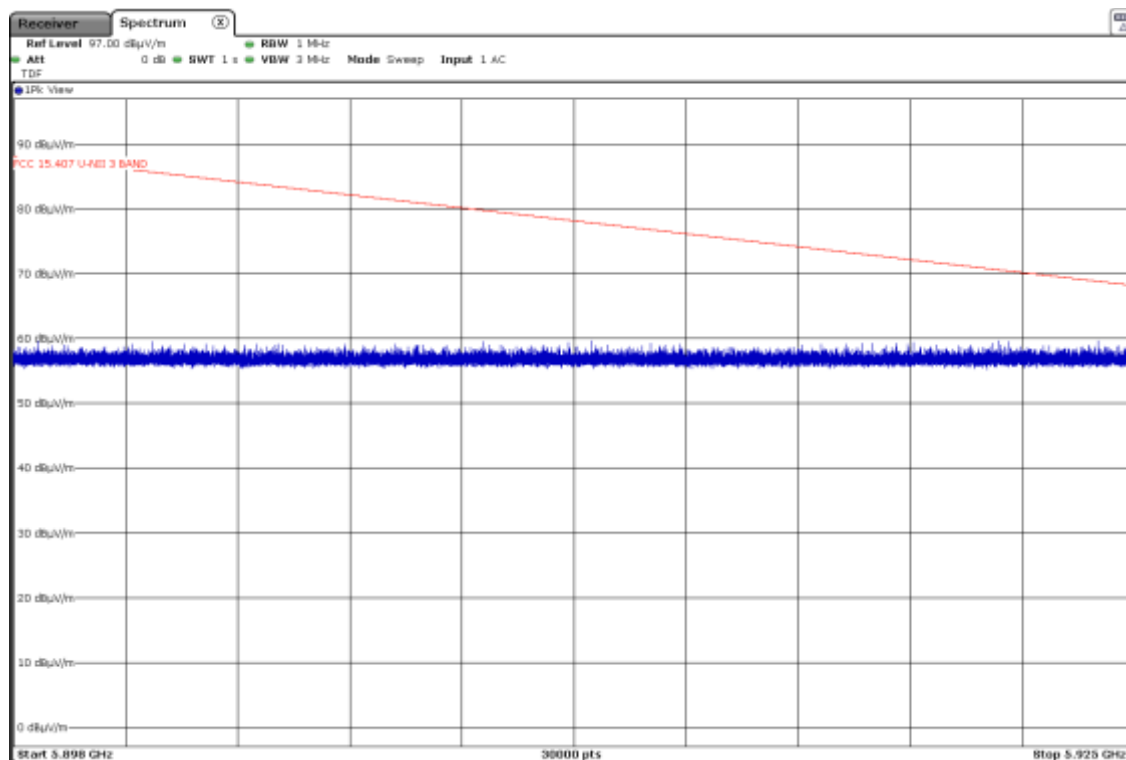


- High Channel 165 (5825 MHz):

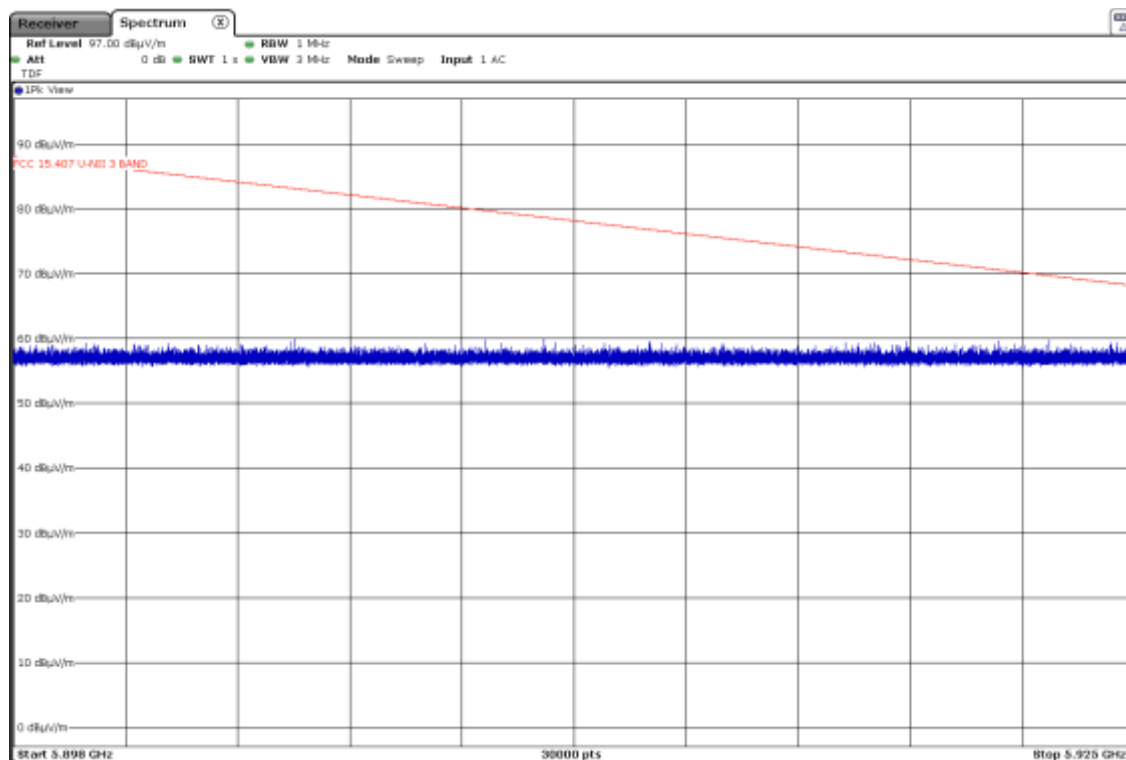


Radiated spurious emissions at band-edges and inside adjacent band 5.898 – 5.925 GHz

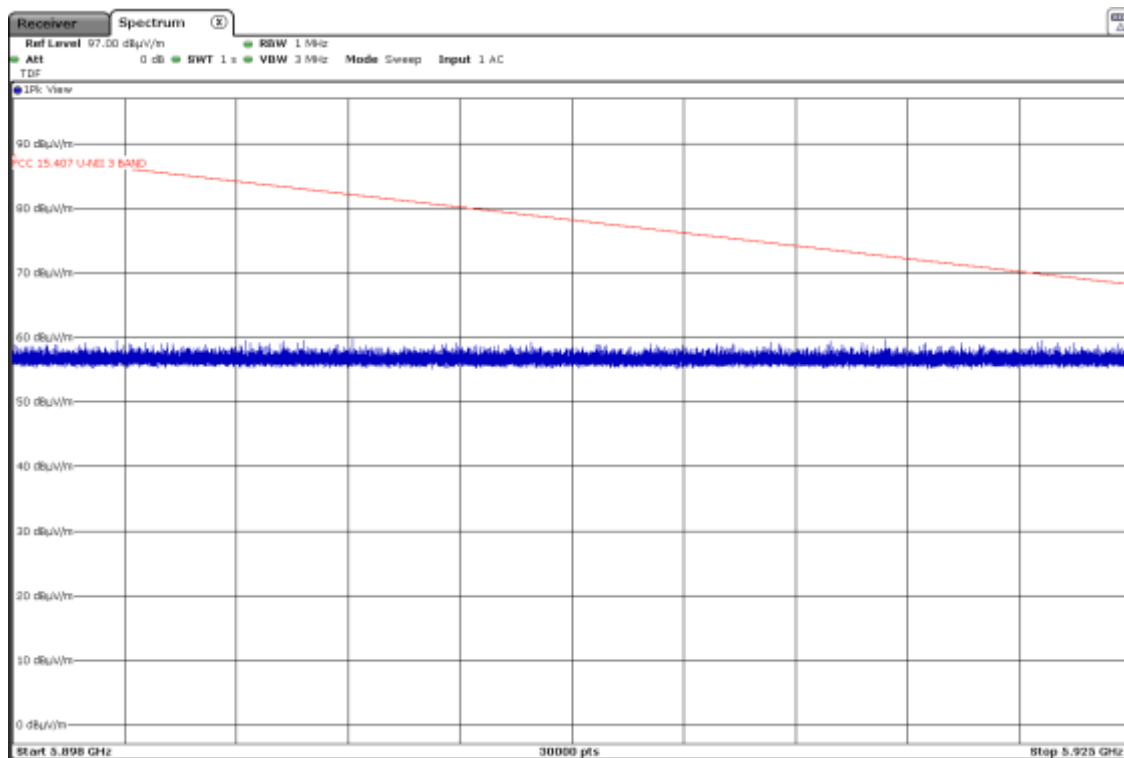
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):



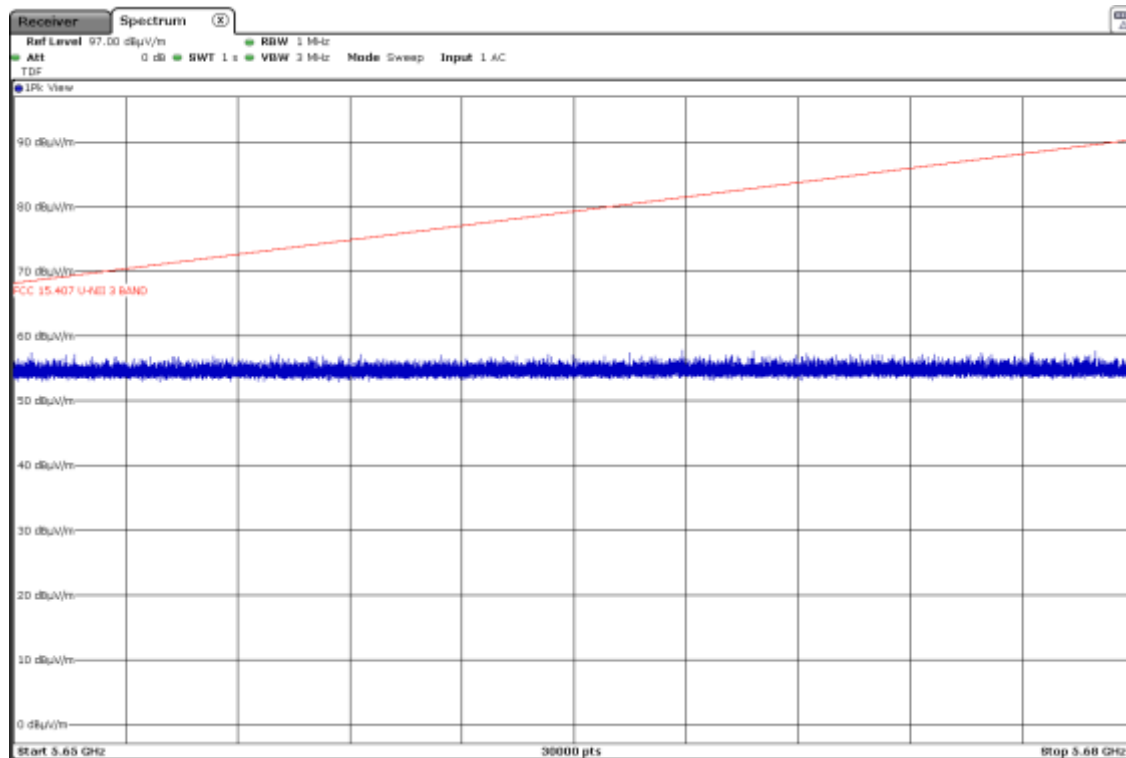
- High Channel 165 (5825 MHz):



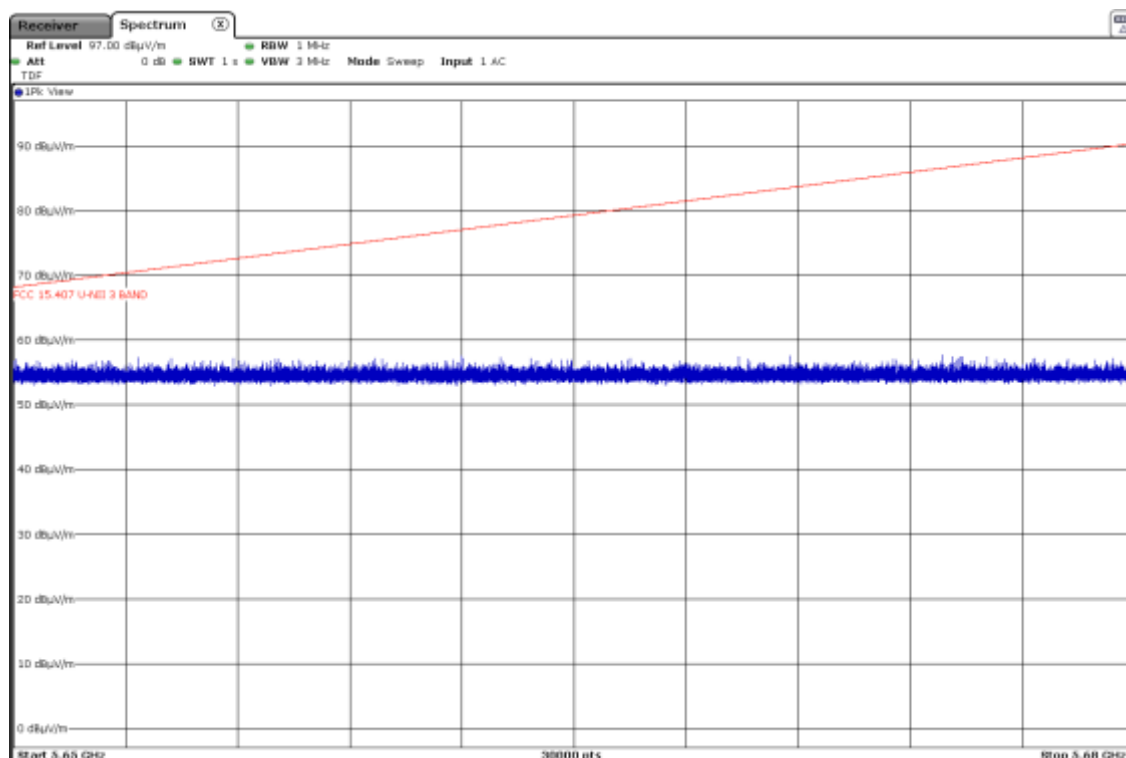
- 802.11 n20:

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

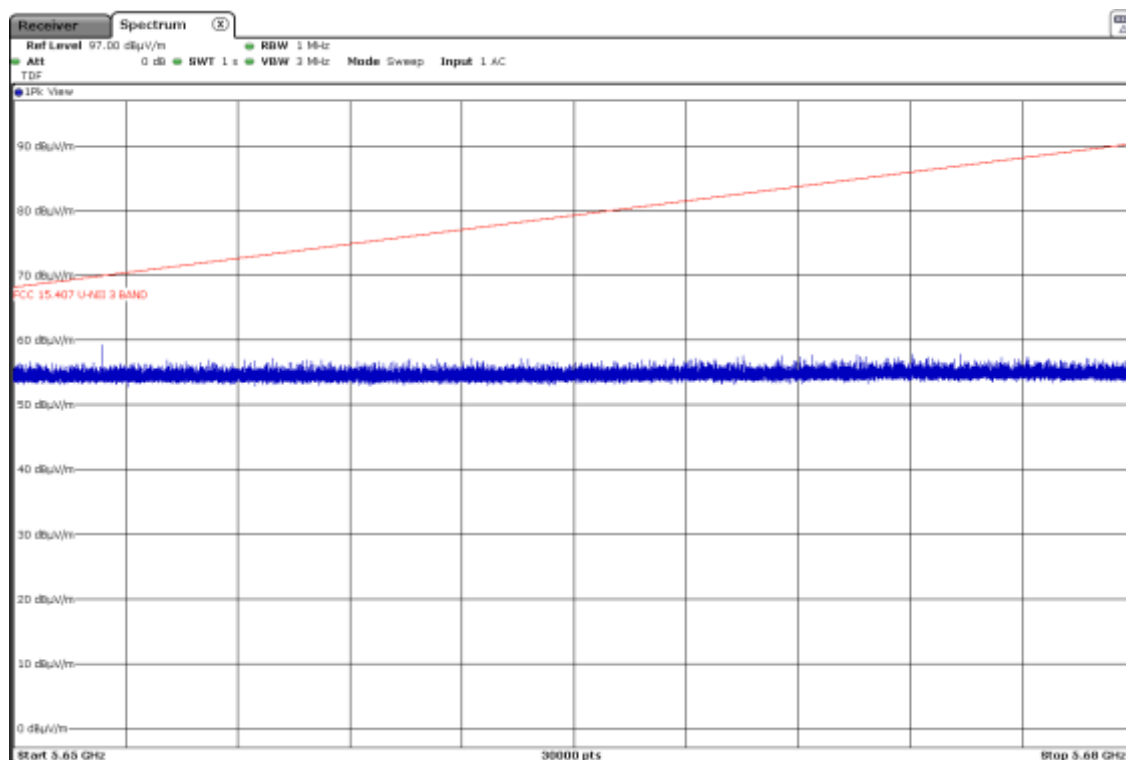
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):

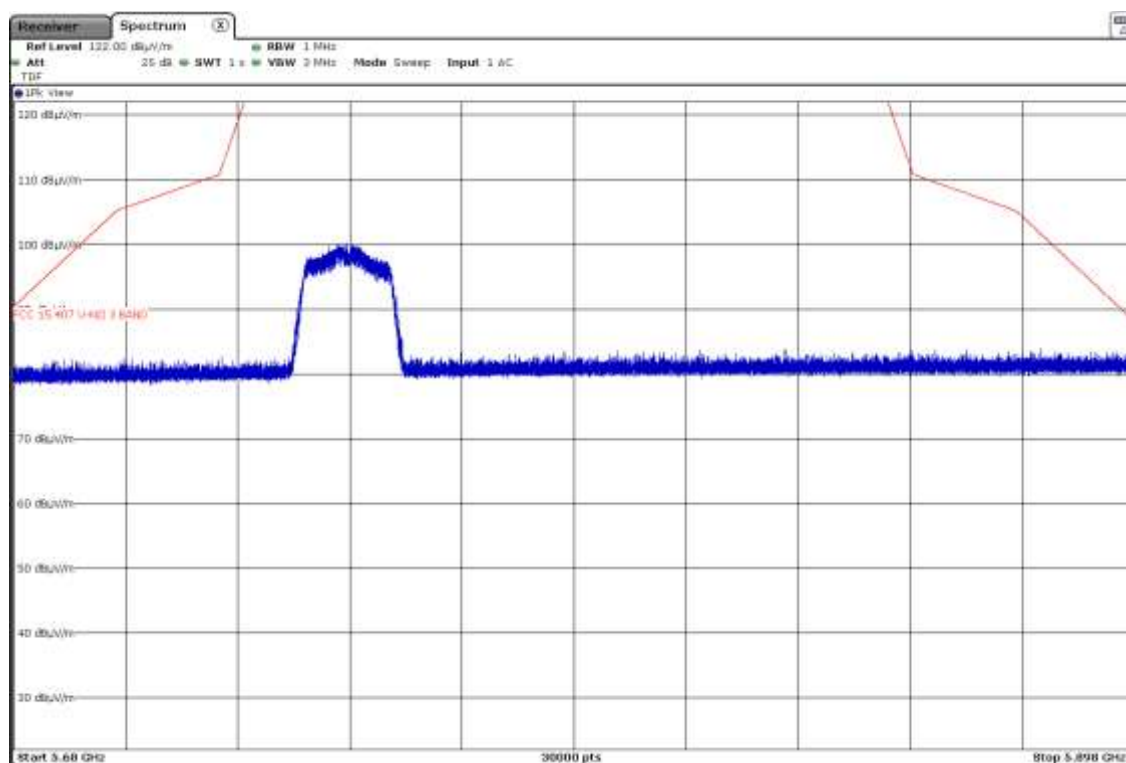


- High Channel 165 (5825 MHz):

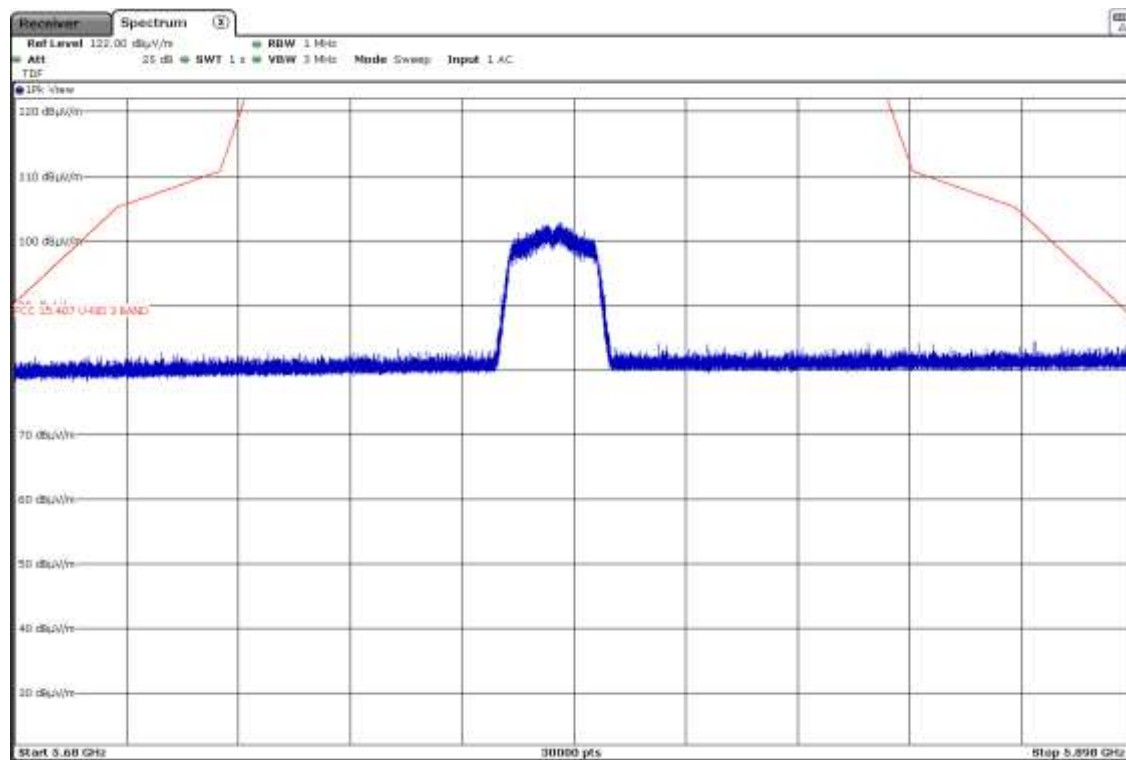


Radiated spurious emissions at band-edges and inside adjacent band 5.68 – 5.898 GHz

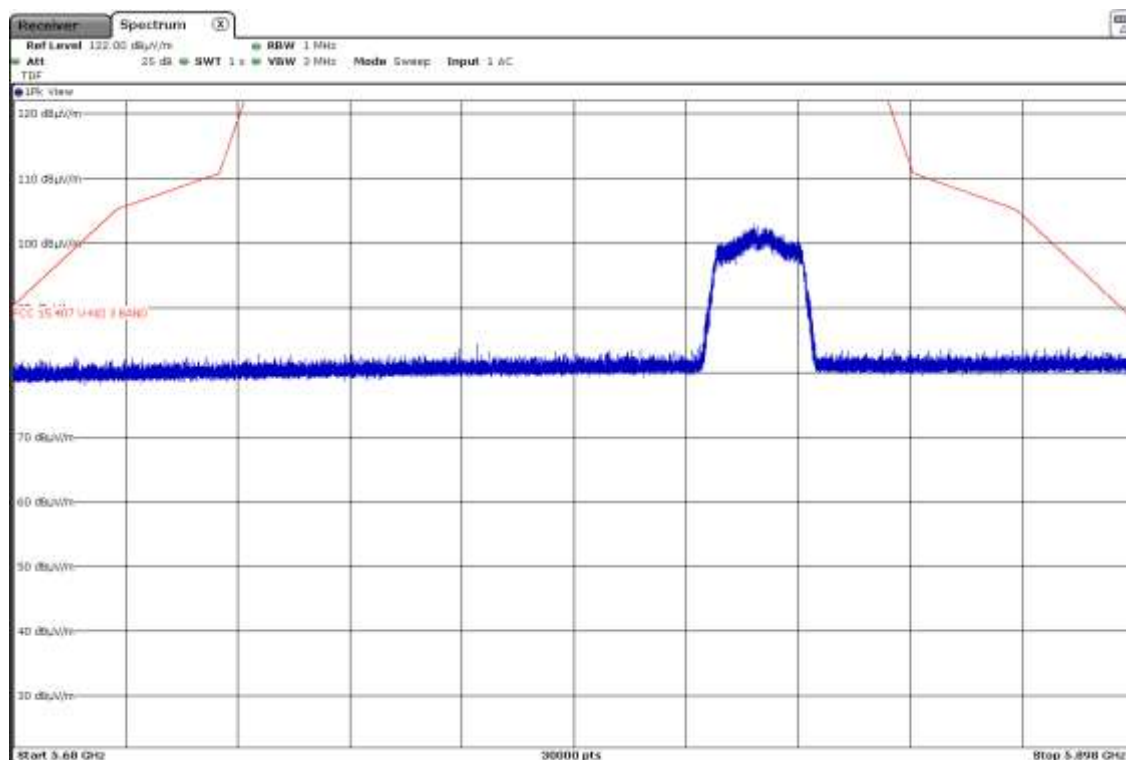
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):

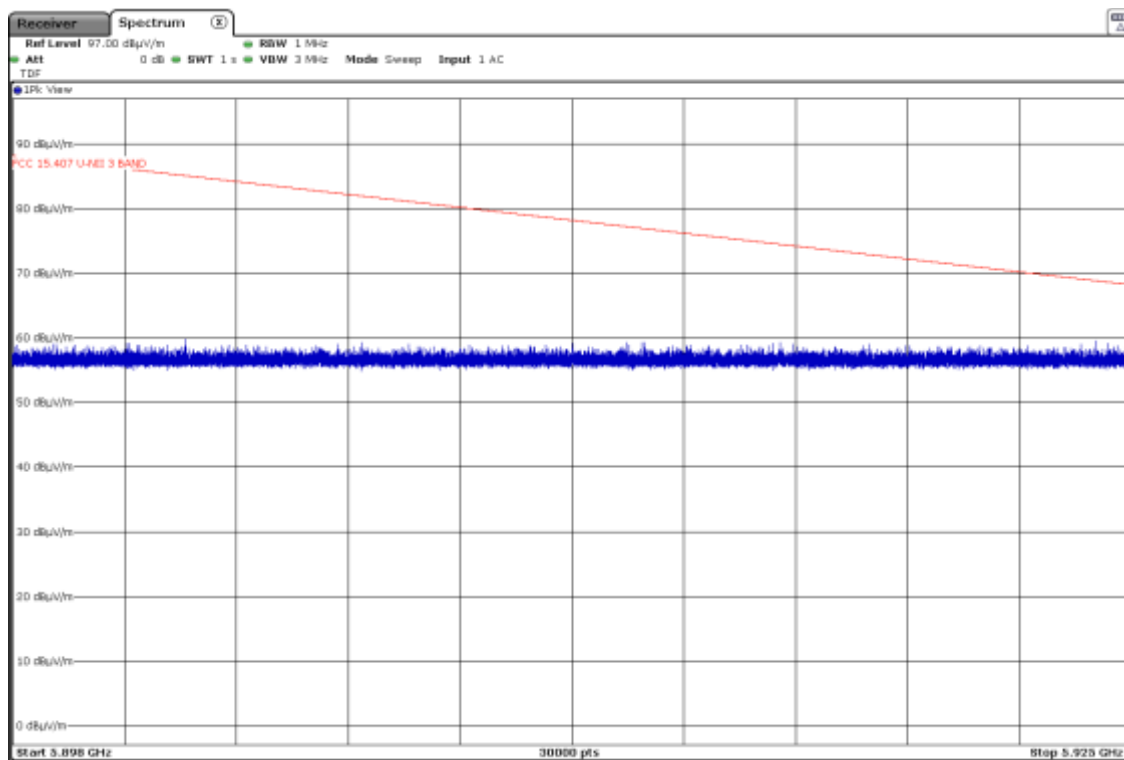


- High Channel 165 (5825 MHz):

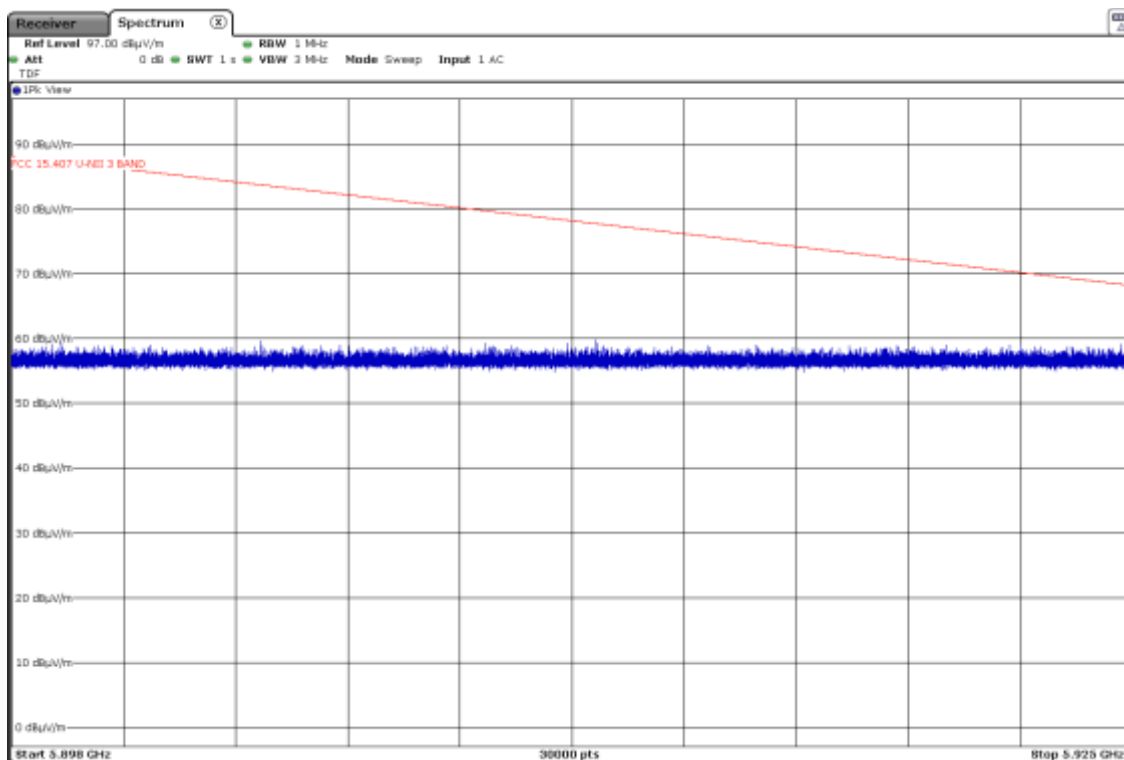


Radiated spurious emissions at band-edges and inside adjacent band 5.898 – 5.925 GHz

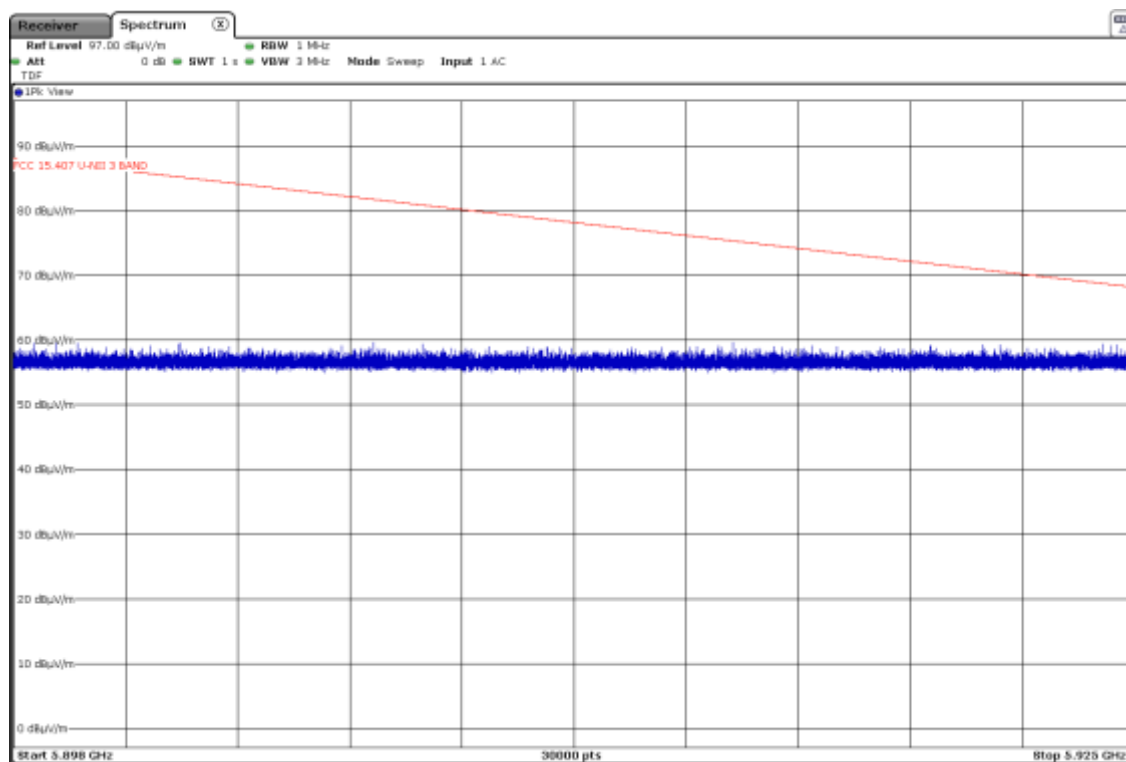
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):



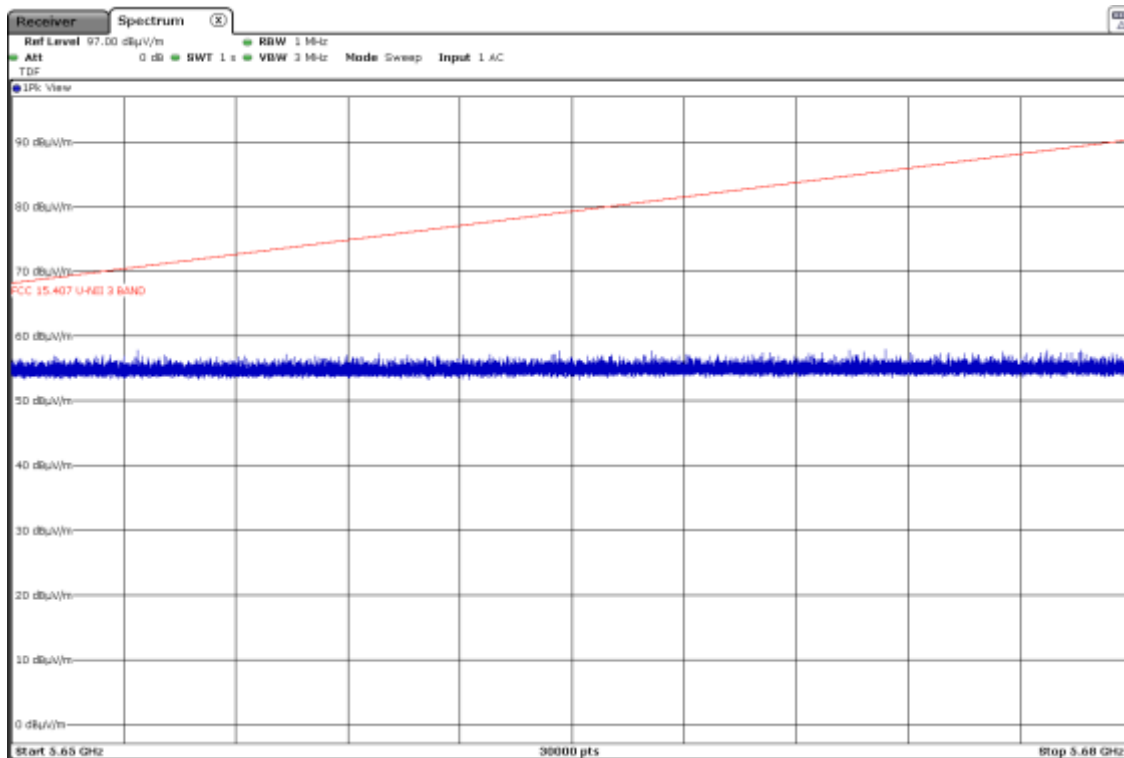
- High Channel 165 (5825 MHz):



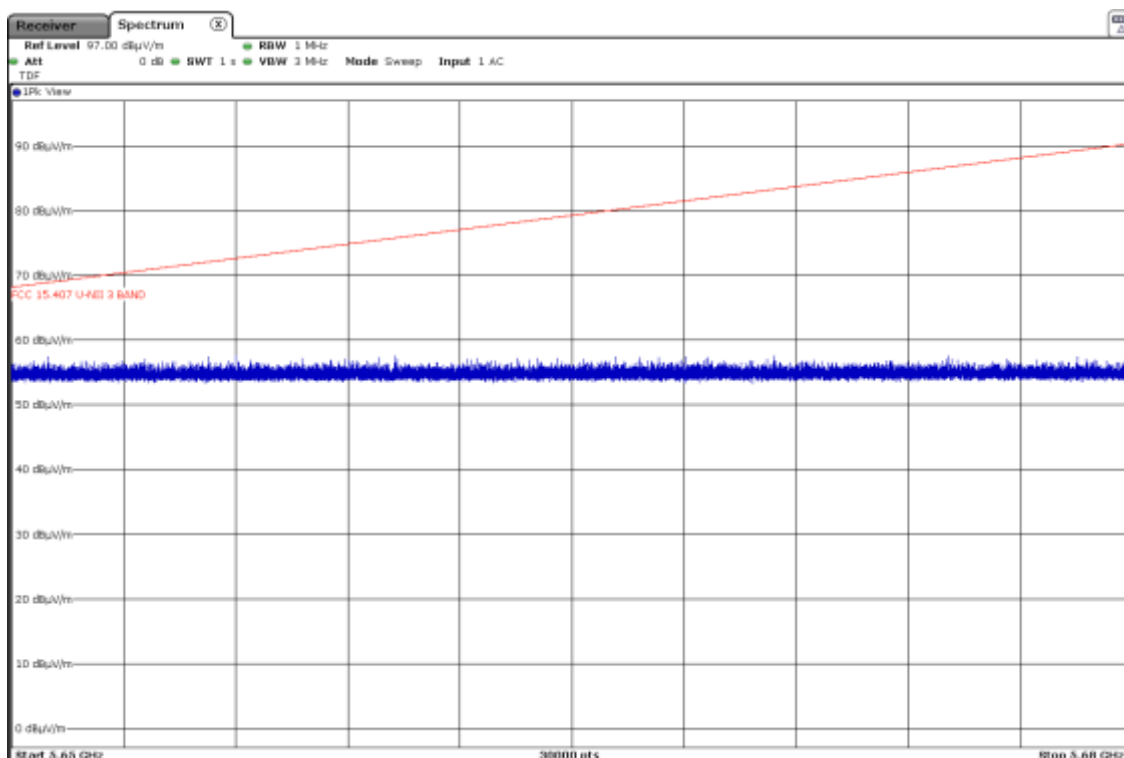
- **802.11 ac20:**

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

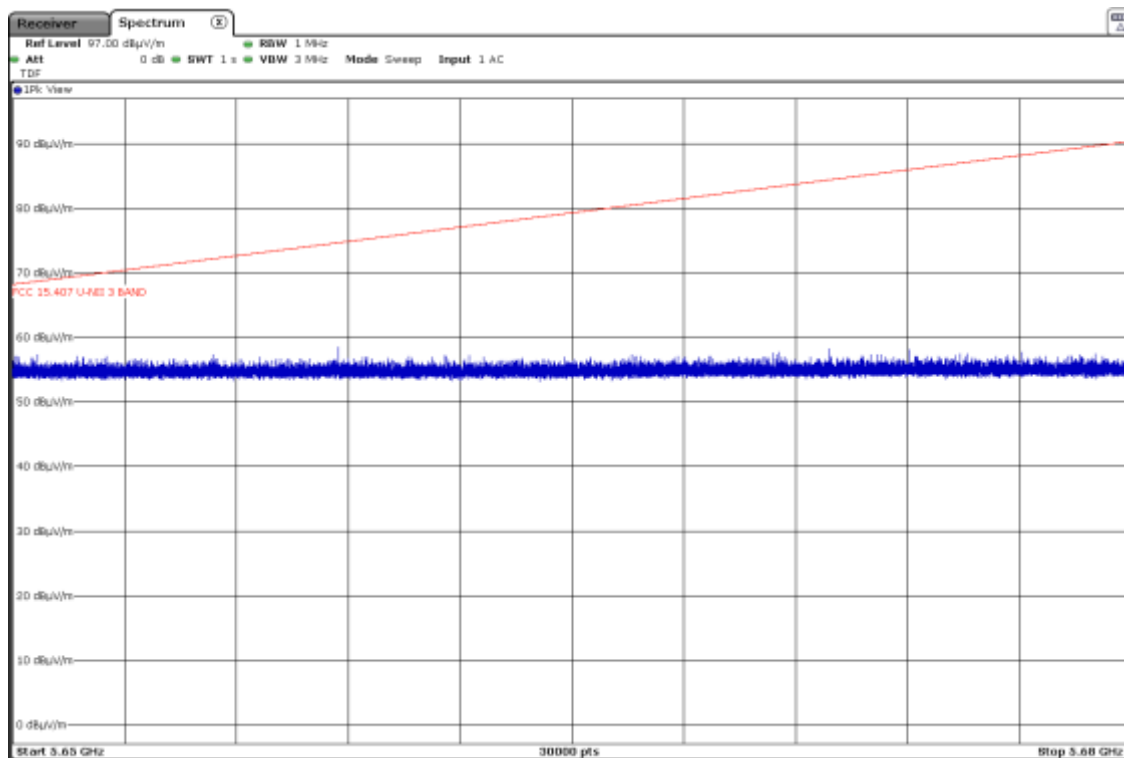
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):

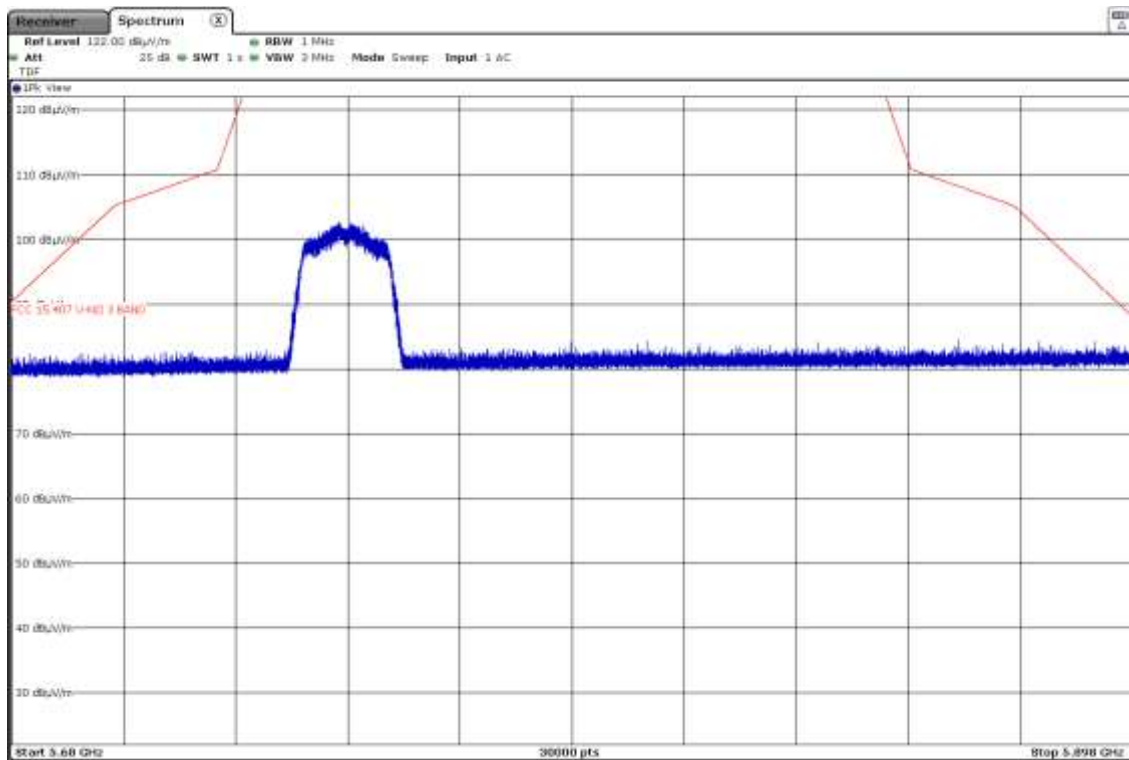


- High Channel 165 (5825 MHz):

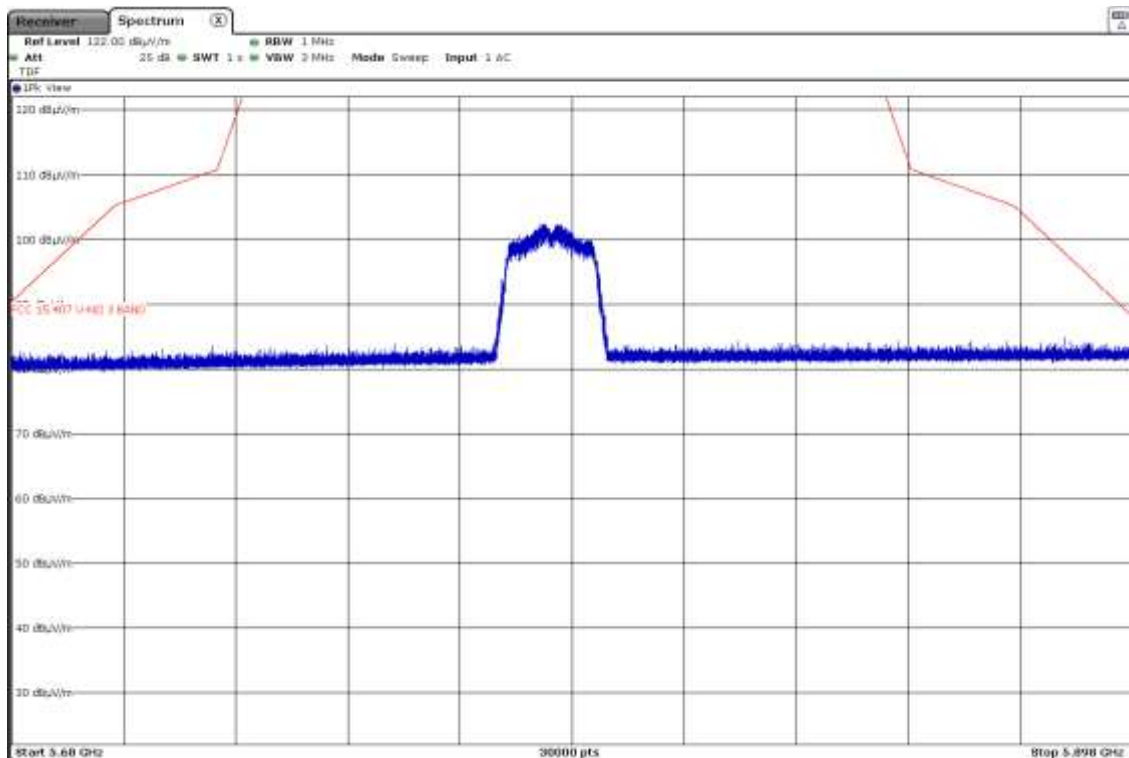


Radiated spurious emissions at band-edges and inside adjacent band 5.68 – 5.898 GHz

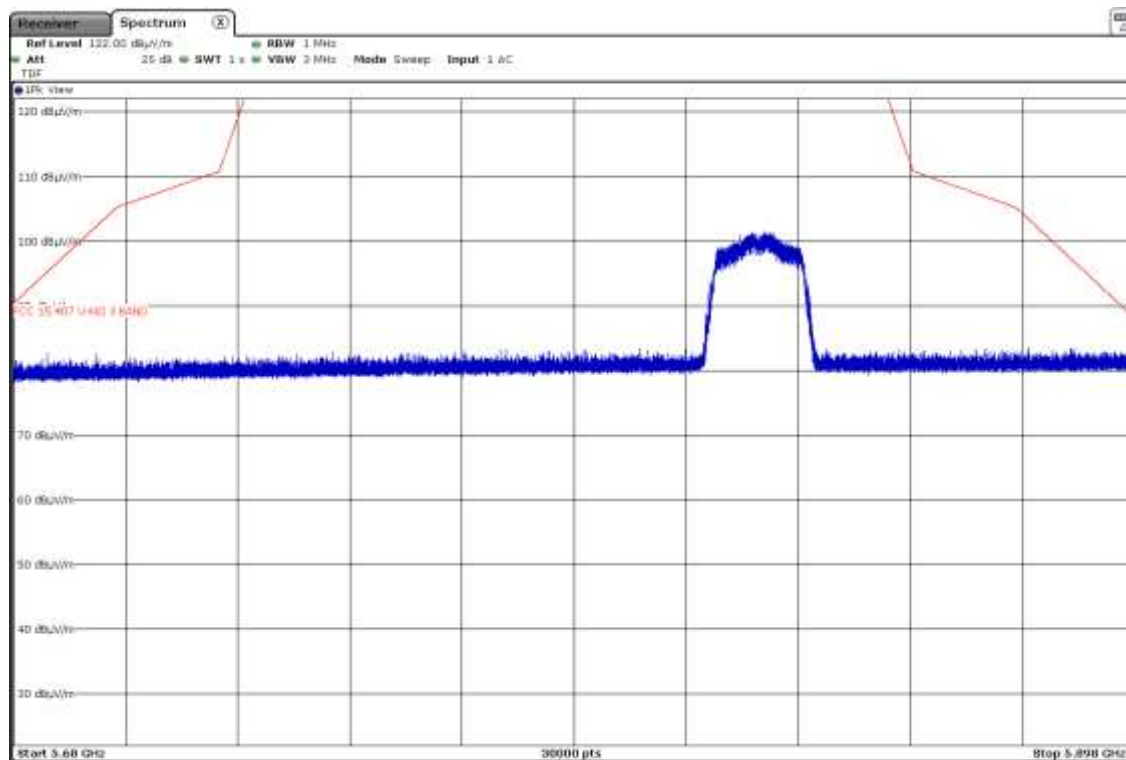
- Low Channel 149 (5745MHz):



- Middle Channel 157 (5785MHz):

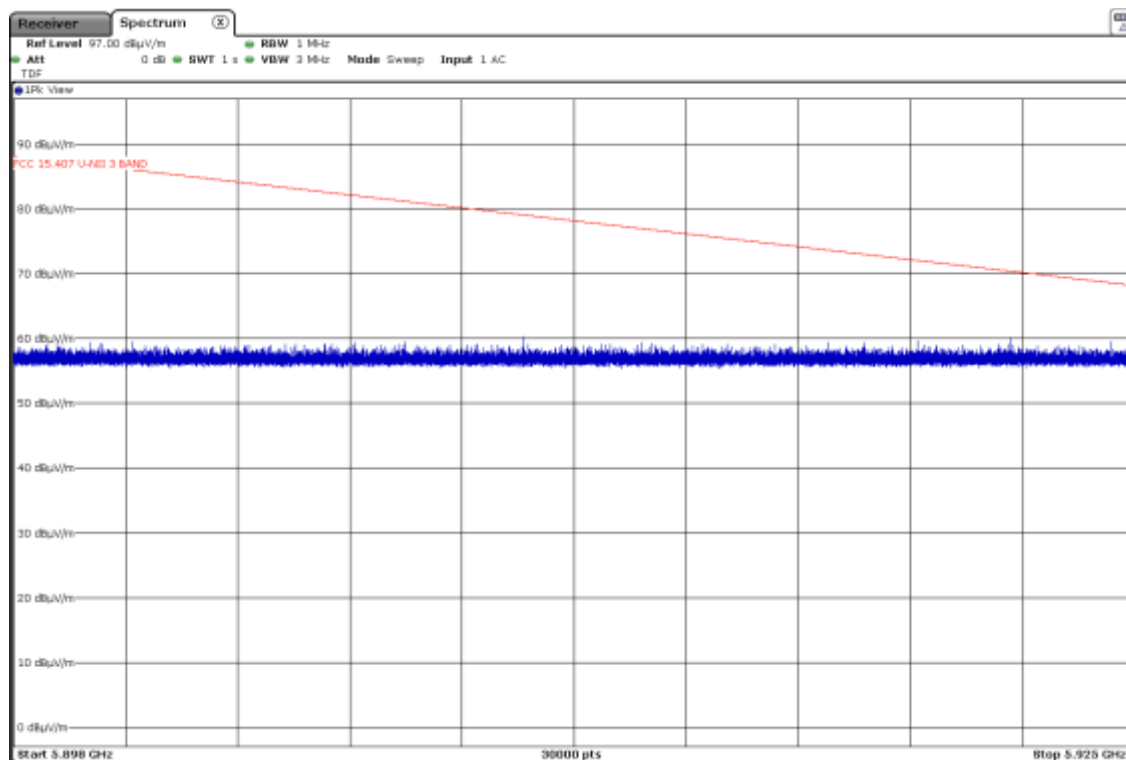


- High Channel 165 (5825MHz):

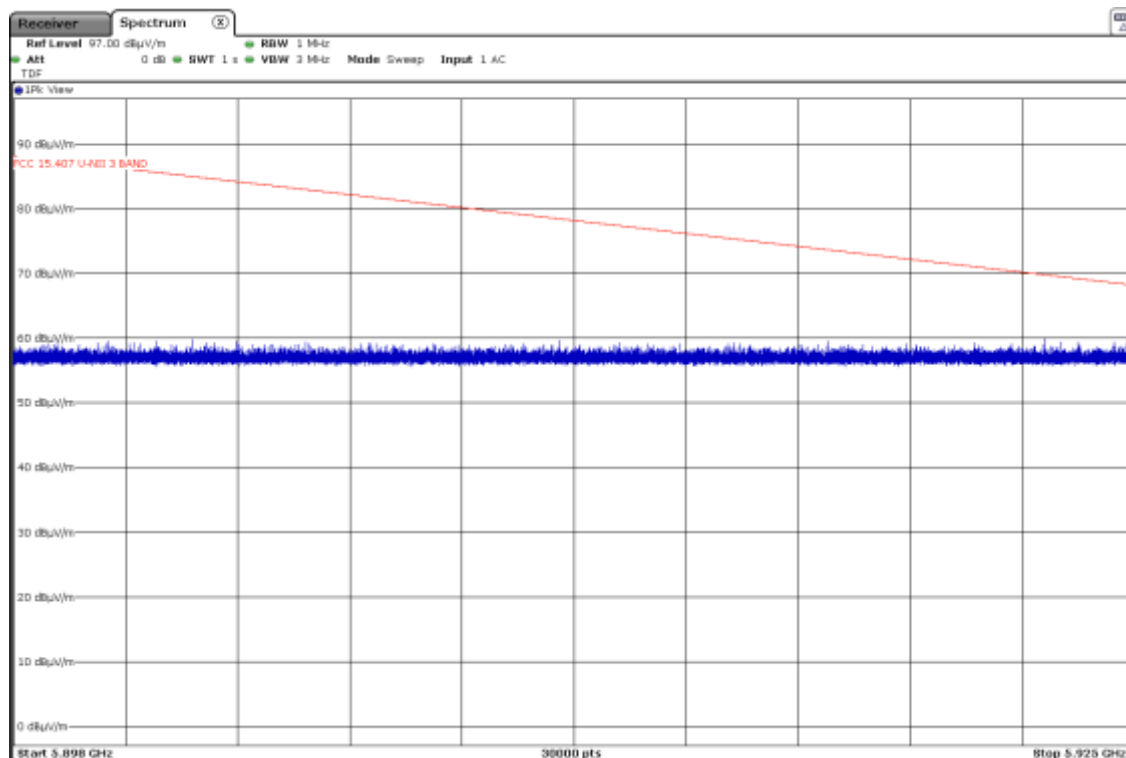


Radiated spurious emissions at band-edges and inside adjacent band 5.898 – 5.925 GHz

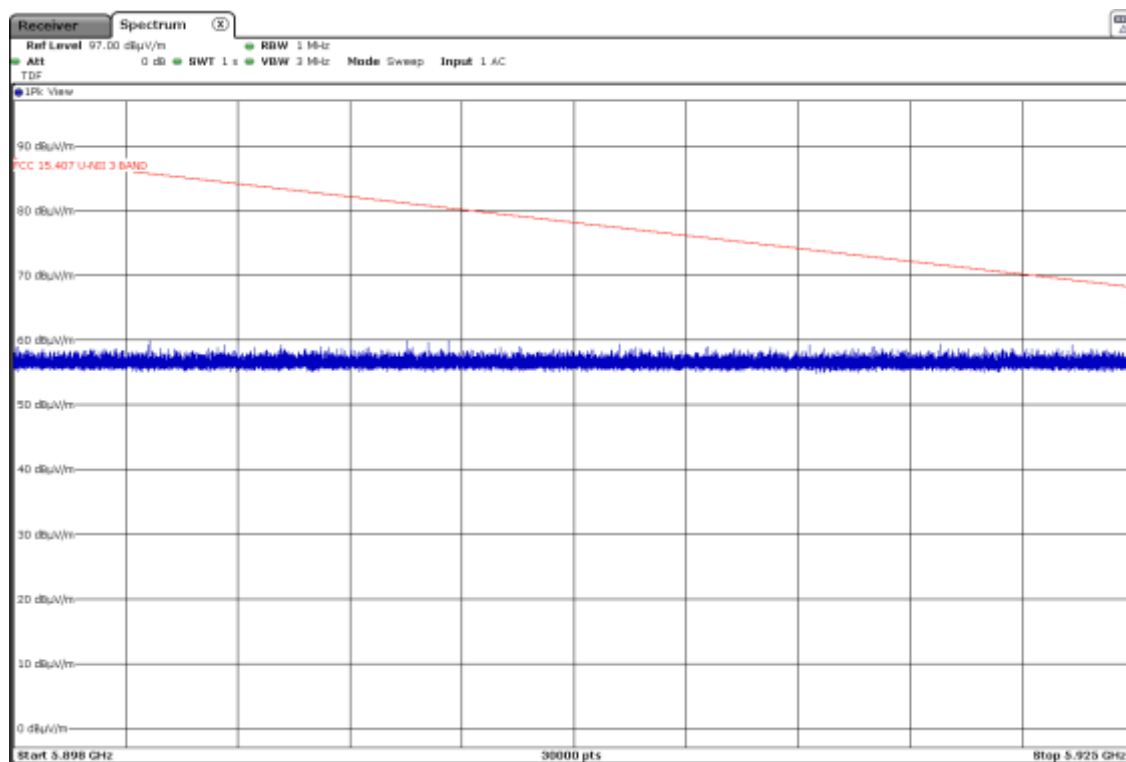
- Low Channel 149 (5745 MHz):



- Middle Channel 157 (5785 MHz):



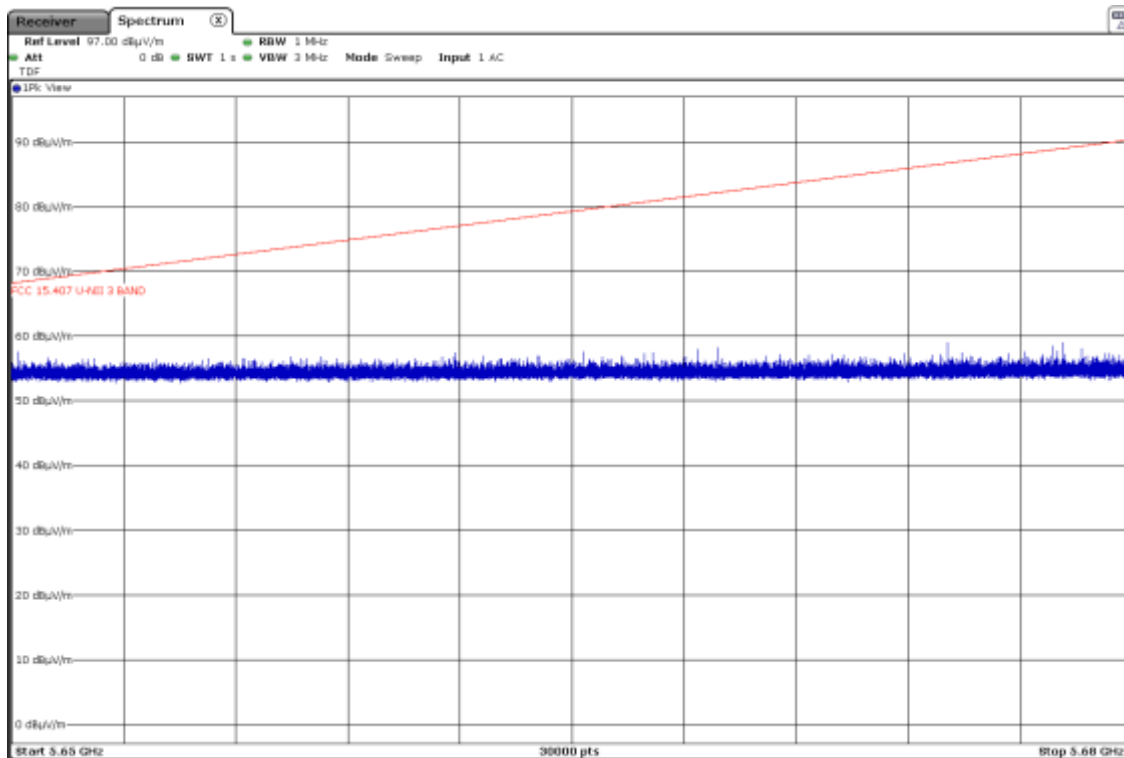
- High Channel 165 (5825 MHz):



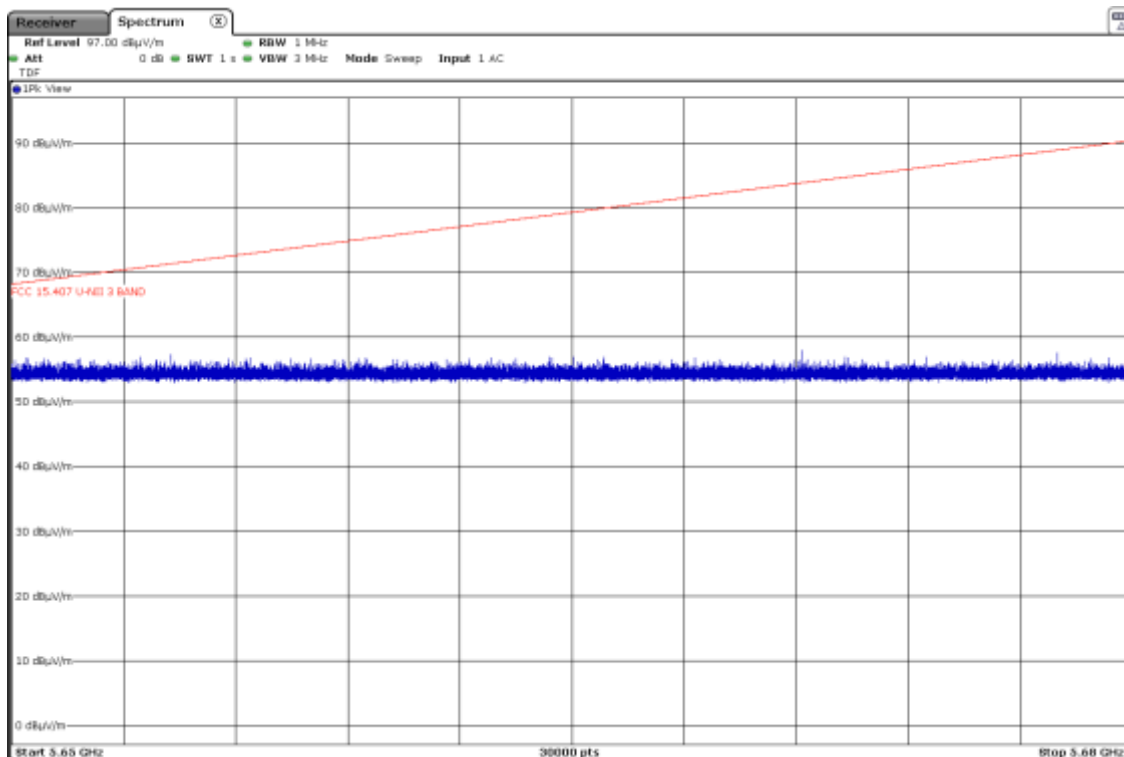
- 802.11 n40:

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

- Low Channel 151 (5755 MHz):

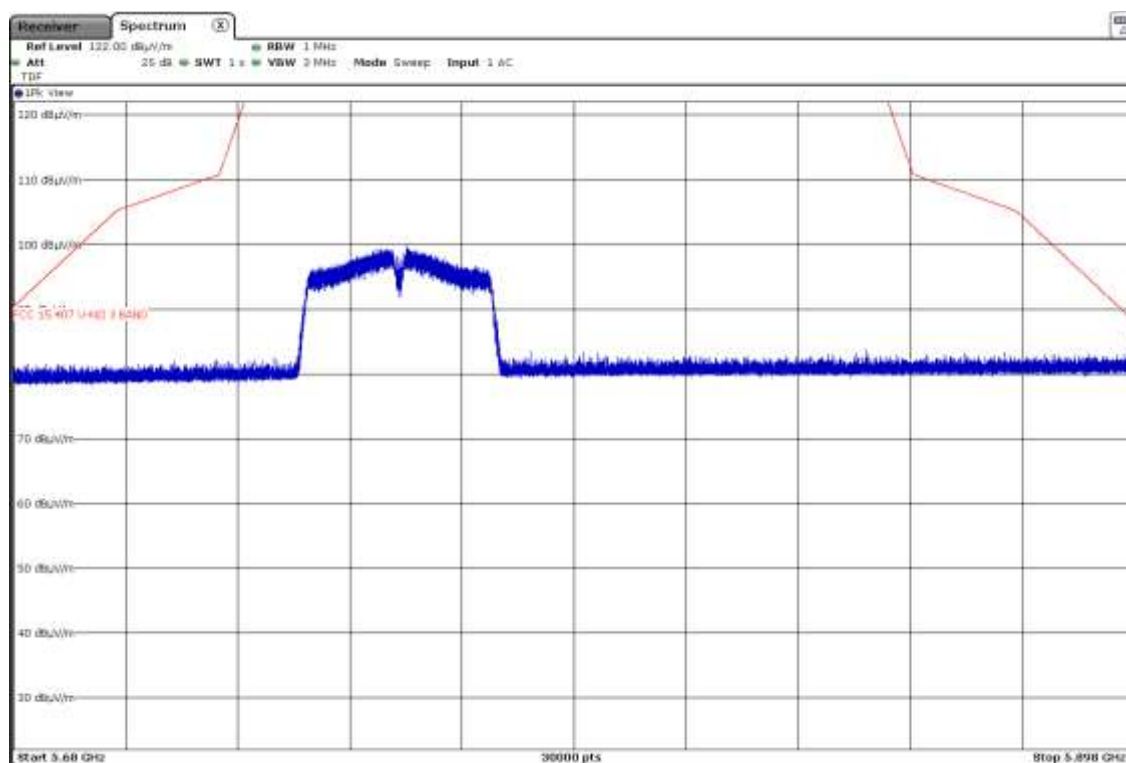


- High Channel 159 (5795 MHz):

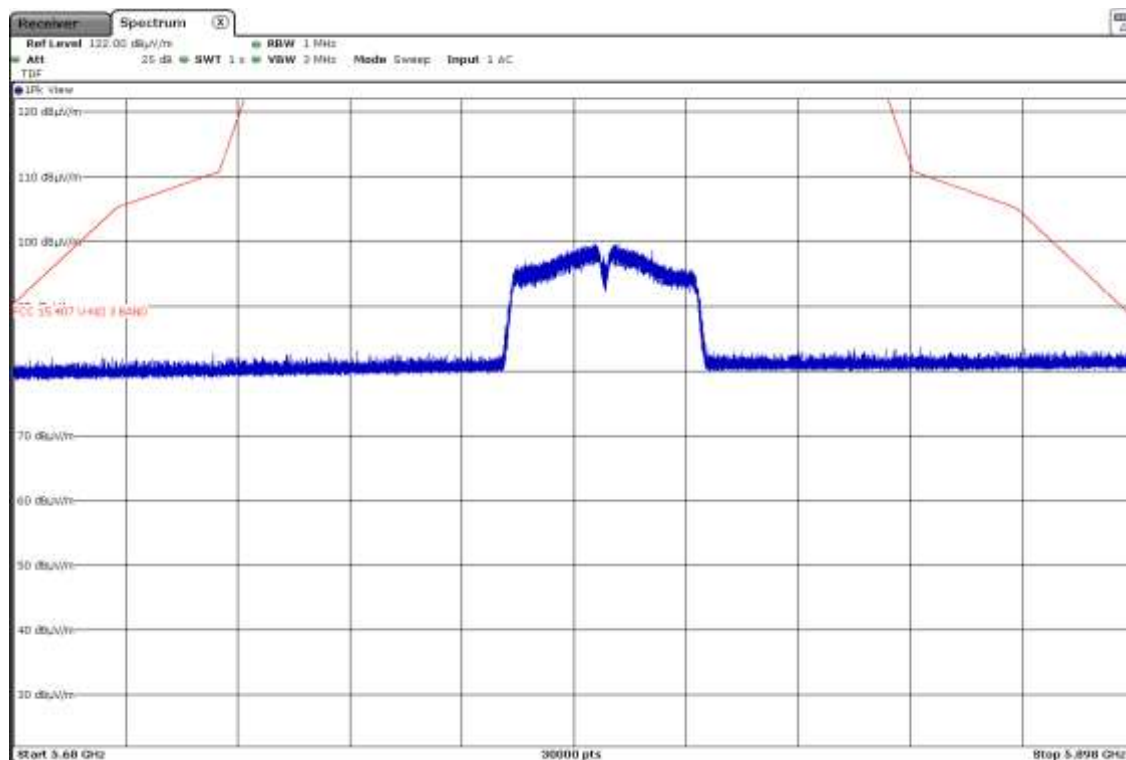


Radiated spurious emissions at band-edges and inside adjacent band 5.68 – 5.898 GHz

- Low Channel 151 (5755 MHz):

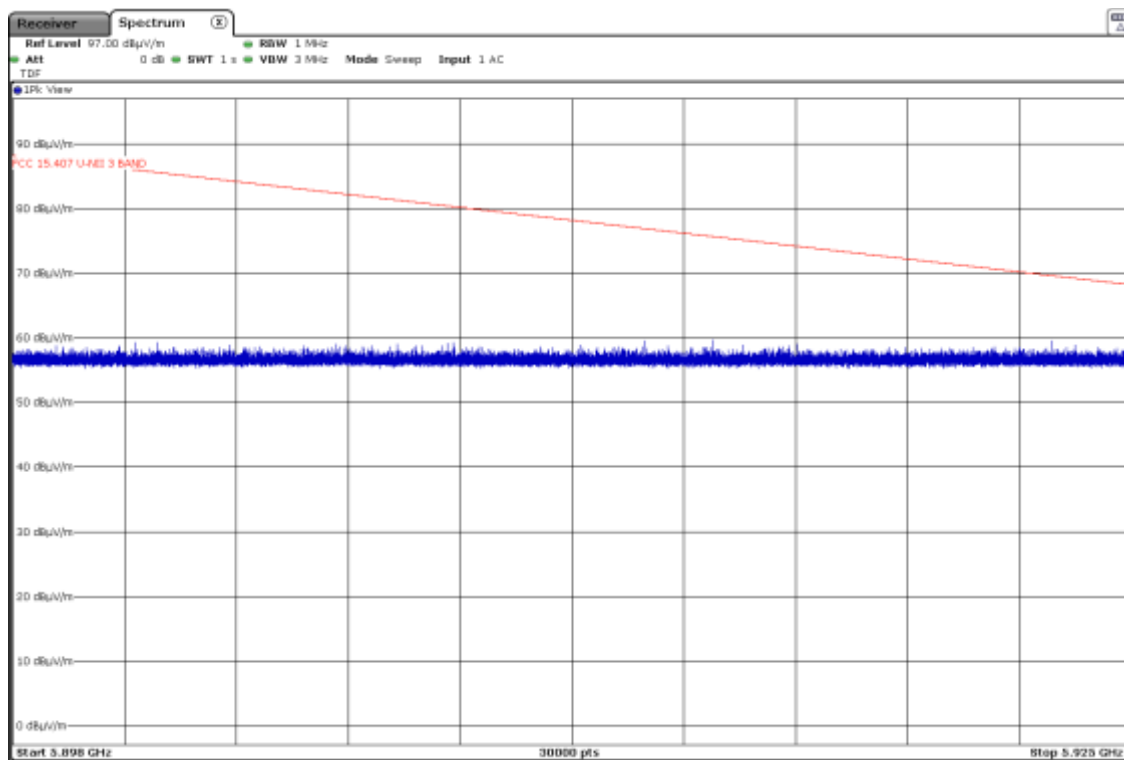


- High Channel 159 (5795 MHz):

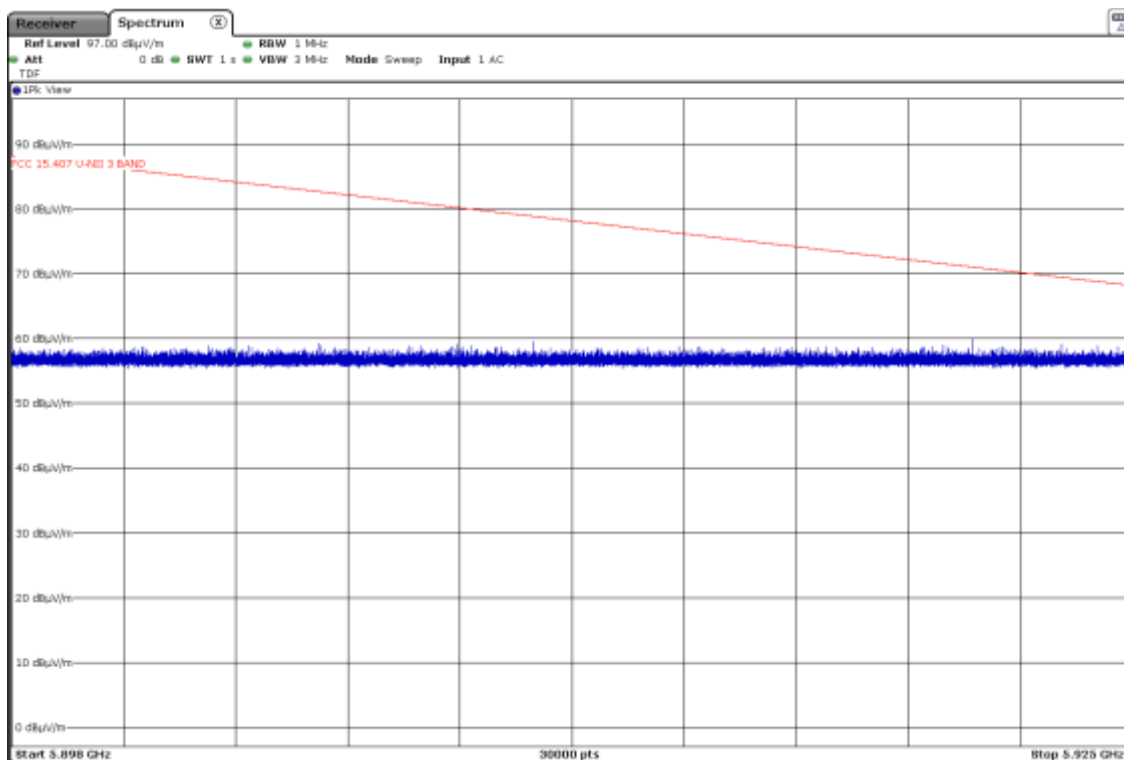


Radiated spurious emissions at band-edges and inside adjacent band 5.898 – 5.925 GHz

- Low Channel 151 (5755 MHz):



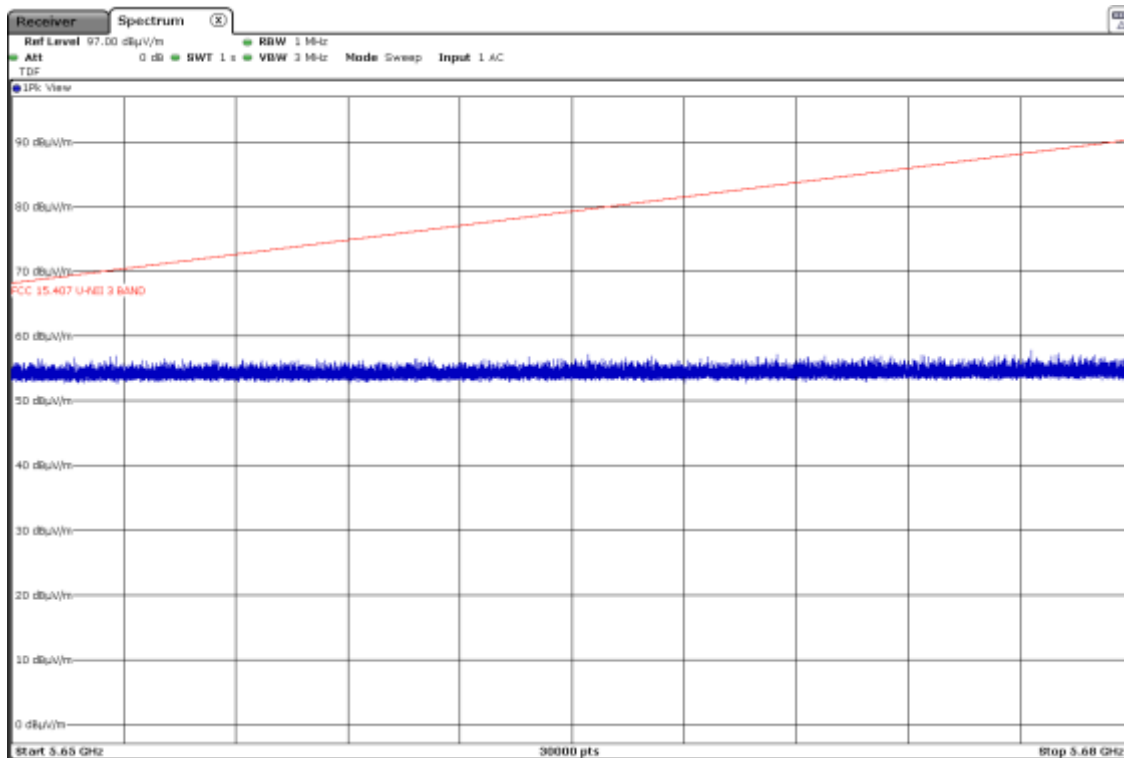
- High Channel 159 (5795 MHz):



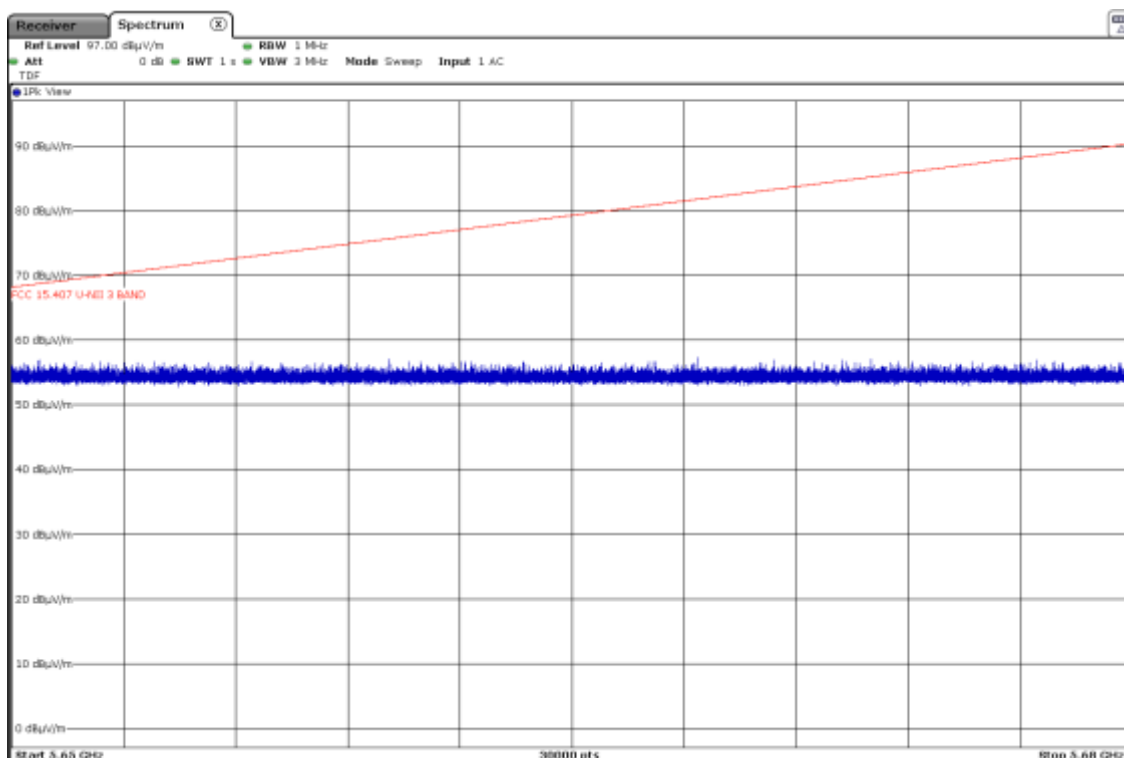
- 802.11 ac40:

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

- Low Channel 149 (5745 MHz):

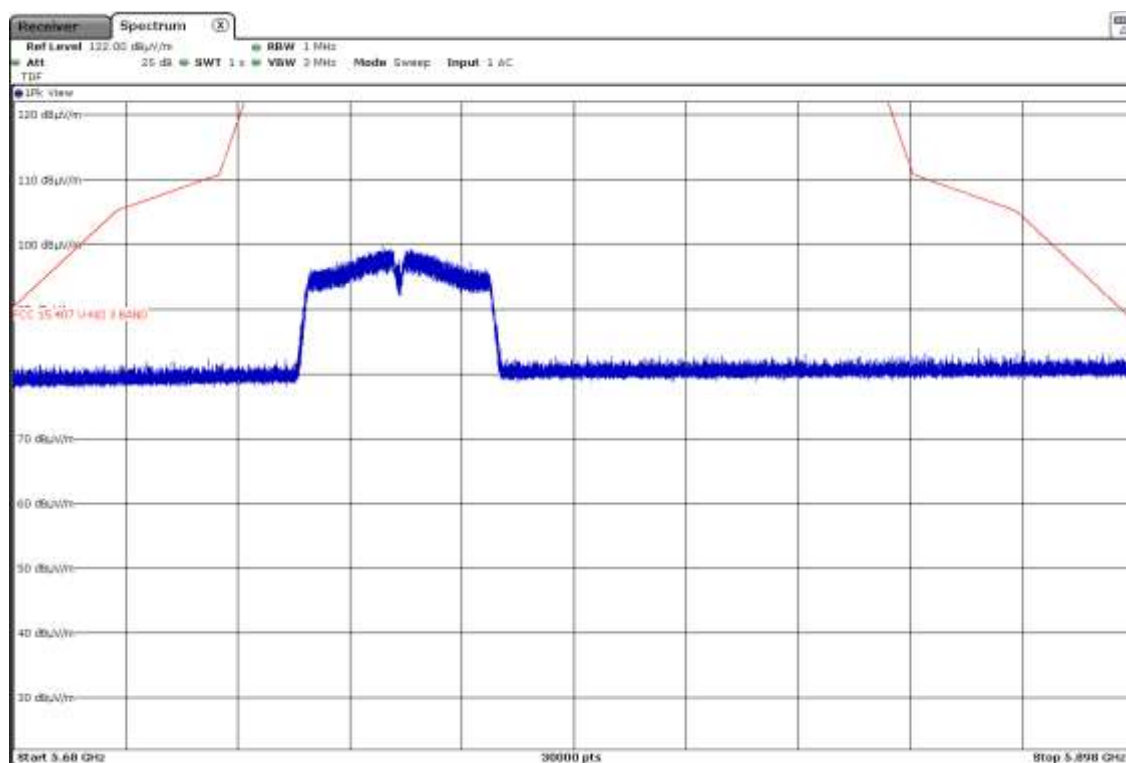


- High Channel 165 (5825 MHz):

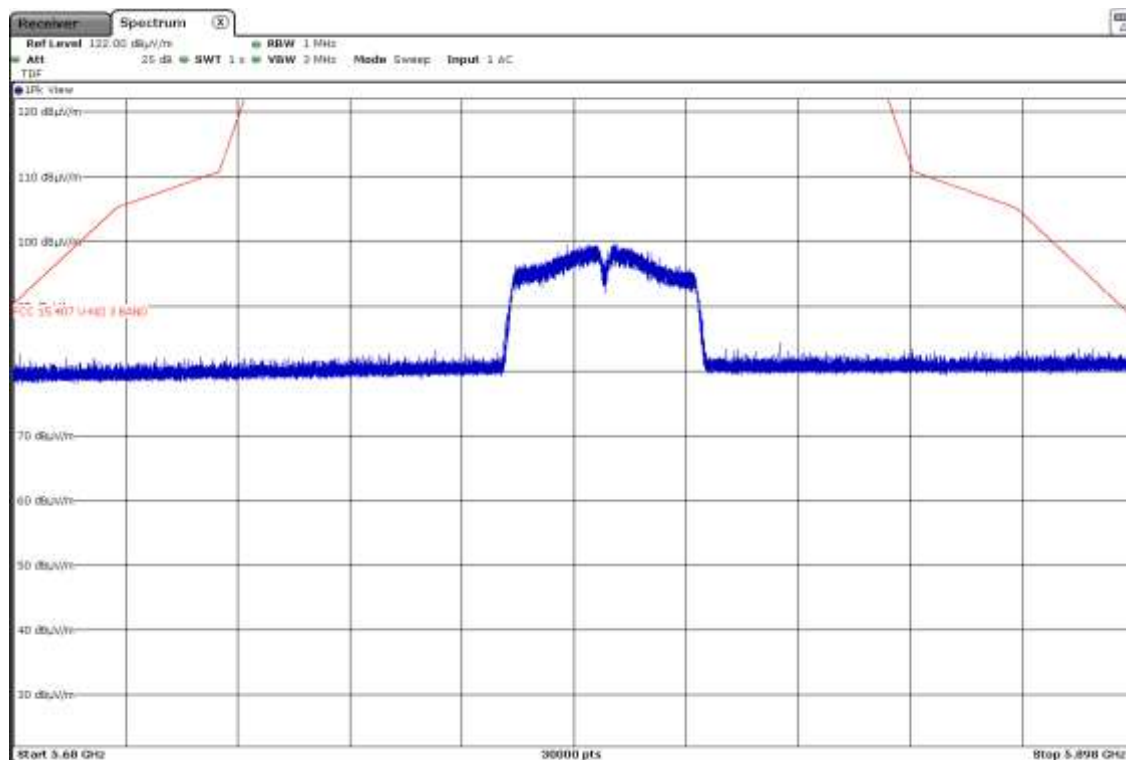


Radiated spurious emissions at band-edges and inside adjacent band 5.68 – 5.898 GHz

- Low Channel 149 (5745 MHz):

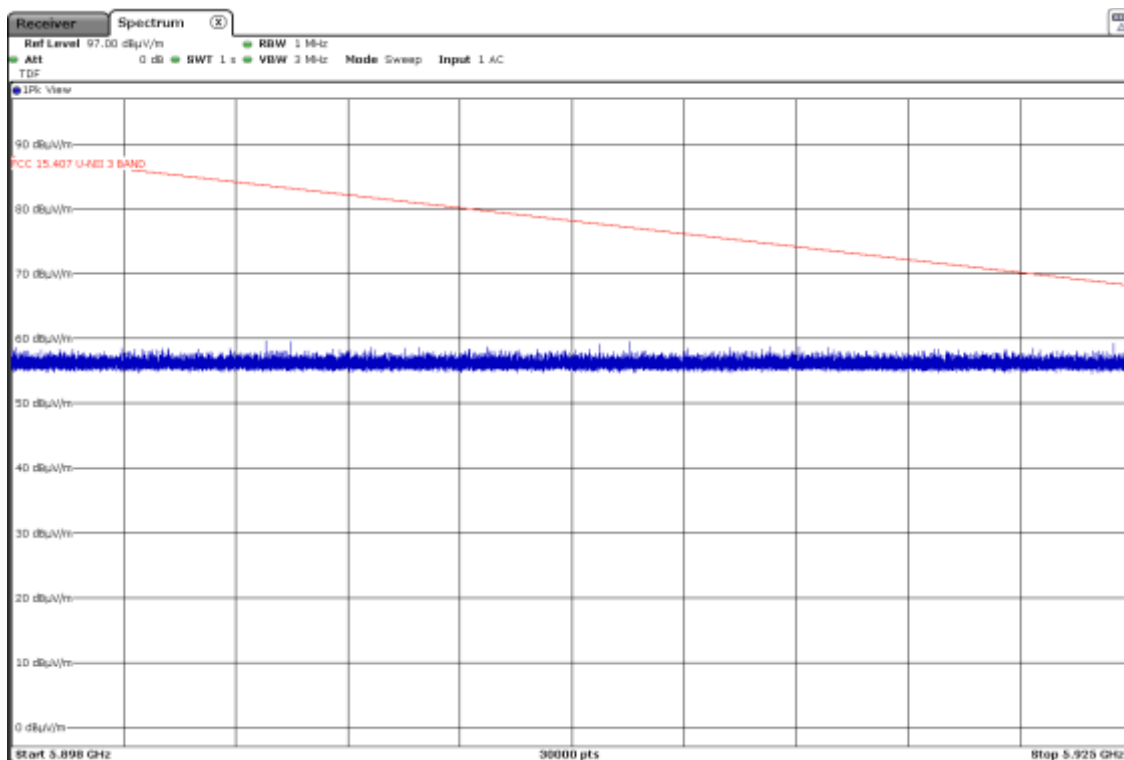


- High Channel 165 (5825MHz):

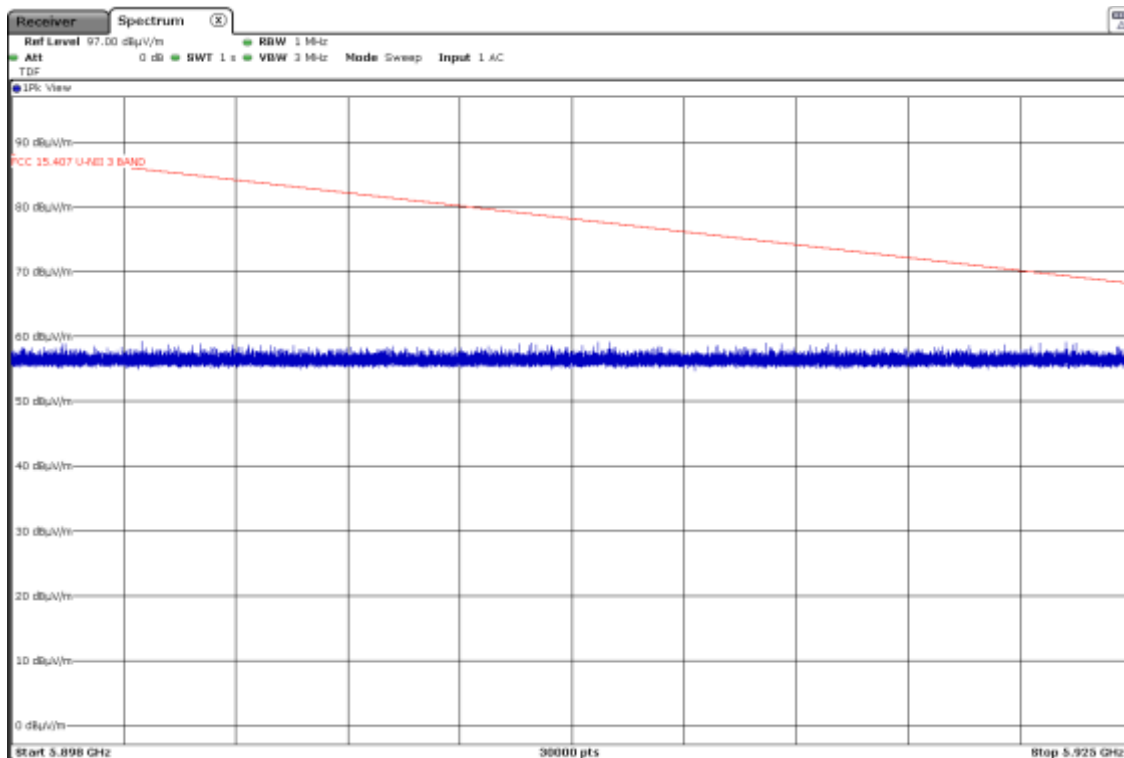


Radiated spurious emissions at band-edges and inside adjacent band 5.898 – 5.925 GHz

- Low Channel 149 (5745 MHz):



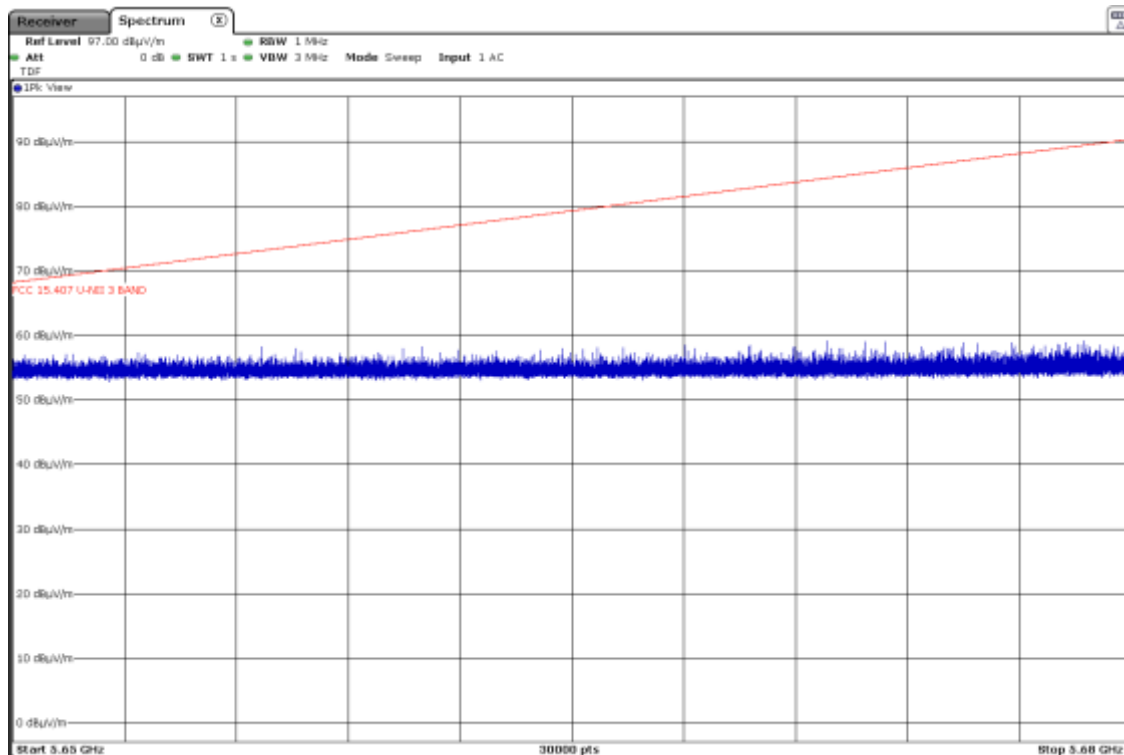
- High Channel 165 (5825 MHz):



- 802.11 ac80:

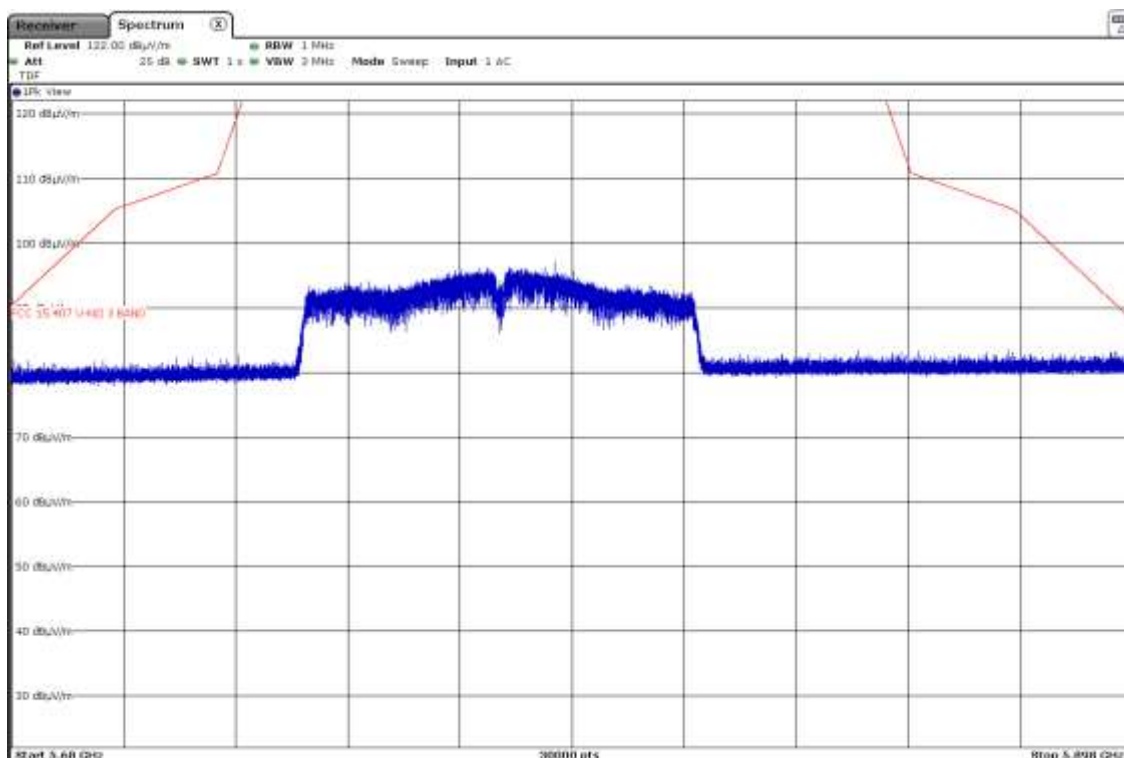
Radiated spurious emissions at band-edges and inside adjacent band 5.65 – 5.68 GHz

- Middle Channel 155 (5775 MHz):



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

- Middle Channel 155 (5775 MHz):



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

- Middle Channel 155 (5775 MHz):

