Test results “WiFi 5.725-5.825 GHz (802.11a/n20/n40/ac80)”

TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 3.3 Vdc

Type of power supply = DC voltage from HMC/NGFC test board.

Type of antenna = External attachable PIFA antenna.

Declared Gain for antenna = 5 dBi

Operating frequencies in the sub-band 5.725-5.825 GHz.

-For IEEE 802.11a, the equipment uses channels 149,153,157,161,165.

-For IEEE 802.11n, there are two bandwidths:

For 20 MHz bandwidth the equipment uses channels 149,153,157,161,165.
For 40 MHz bandwidth the equipment uses channels 151 and 159.

-For IEEE 802.11ac80 (80 MHz bandwidth) the equipment uses channel 155.

TEST FREQUENCIES:

For WiFi a/n20:

Lowest channel (149): 5745 MHz

Middle channel (157): 5785 MHz

Highest channel (165): 5825 MHz

For WiFi n40:

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 FCC DTS Measurement KDB 558074 D01 DTS Meas Guidance v03r01.

For 802.11a mode the EUT can transmit at both CHAIN A and CHAIN B RF outputs individually, but not simultaneously.

For 802.11n modes 802.11n20 (20 MHz channel bandwidth), 802.11n40 (40MHz channel bandwidth) and 802.11ac80 (80MHz channel bandwidth) mode the EUT can transmit at both CHAIN A and CHAIN B RF outputs individually and simultaneously.

For radio testing purposes the card was installed in a test fixture. The test fixture is connected to a laptop computer and dc power supplied. The laptop computer was used to configure the EUT to continuously transmit at a specified output power with different modes and modulation schemes.

The PC was using the Intel test utility DRTU Version 1.7.3-859

During transmitter test the EUT was being controlled by the Intel DRTU tool to operate in a continuous transmit mode on the test channels as required and in each of the different modulation modes.

The data rates of 6Mb/s for 802.11a, HT0 (SISO)/HT8 (MIMO) for 802.11n20 and n40, and VHT0 (SISO)/(MIMO) for 802.11 ac80 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 conducted RF output power at each chain was adjusted according to the client's supplied Target values (see following table) using the Intel DRTU tool and measuring the power by using a calibrated average power meter. Measured values for adjustment were within -0.2 dB/+0.3 dB respect to the Target values.

RF conducted output power target values

Mode	BW (MHz)	Channel / Freq.	SISO Chain A (dBm)	SISO Chain B (dBm)	MIMO at both ports A and B (dBm)
802.11a	20	149 / 5745	15.5	15	n/a
		157 / 5785	15.5	15	n/a
		165 / 5825	15.5	15	n/a
802.11n	20	149 / 5745	15.5	15	13.50
		157 / 5785	15.5	15	13.50
		165 / 5825	15.5	15	13.50
802.11n*	40	151 / 5755	16.5	16.5	16.50
		159 / 5795	16.5	16.5	16.50
802.11ac	80	155 / 5775	16.5	16.5	16.50

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a calibrated low loss RF cable. The reading in the spectrum analyser is compensated with the cable loss at each measurement frequency.

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and 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 (wooden) platform one meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º 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.

Occupied Bandwidth

RESULTS

1. WiFi 5GHz 802.11 a mode

Occupied Bandwidth (see next plots).

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
99% bandwidth (MHz)	16.712	16.668	16.625	16.627	16.683	16.644
Measurement uncertainty (kHz)	±21.7					

2. WiFi 5GHz 802.11 n20 mode

Occupied Bandwidth (see next plots).

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
99% bandwidth (MHz)	17.804	17.777	17.779	17.753	17.801	17.784
Measurement uncertainty (kHz)	±21.7					

3. WiFi 5GHz 802.11 n40 mode

Occupied Bandwidth (see next plots).

	Lowest frequency 5755 MHz		Highest frequency 5795 MHz	
	Chain A	Chain B	Chain A	Chain B
99% bandwidth (MHz)	35.997	35.996	35.971	35.969
Measurement uncertainty (kHz)	±21.7			

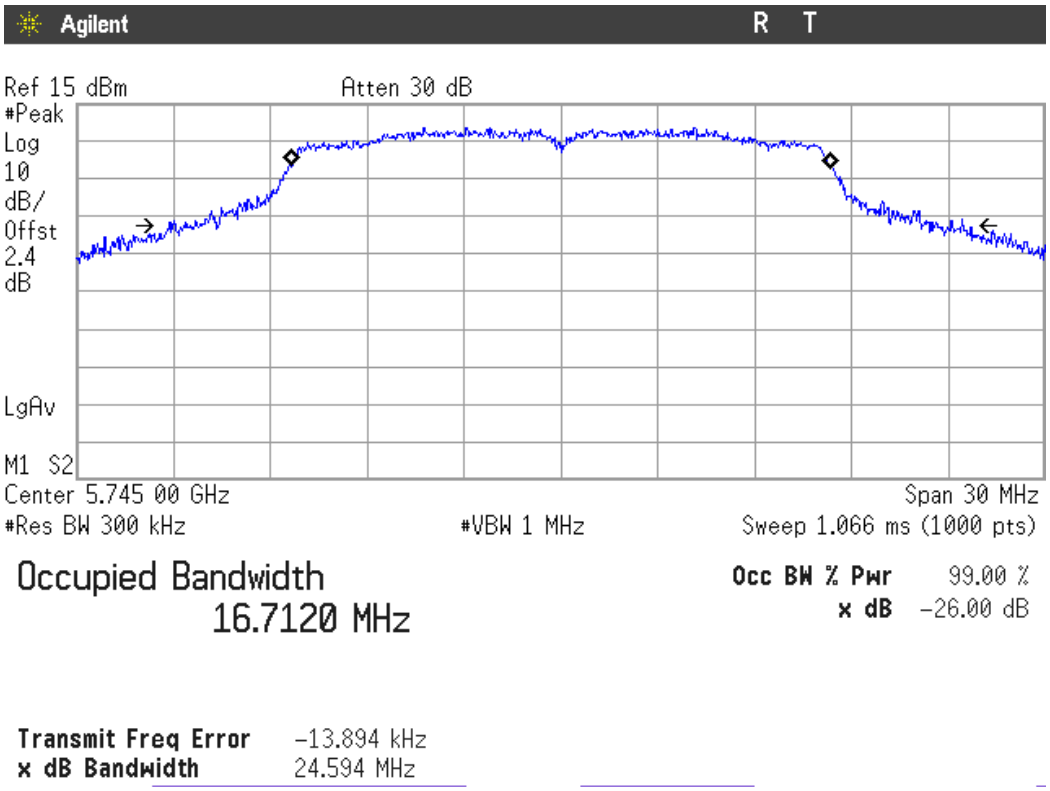
4. WiFi 5GHz 802.11 ac80 mode

Occupied Bandwidth (see next plots).

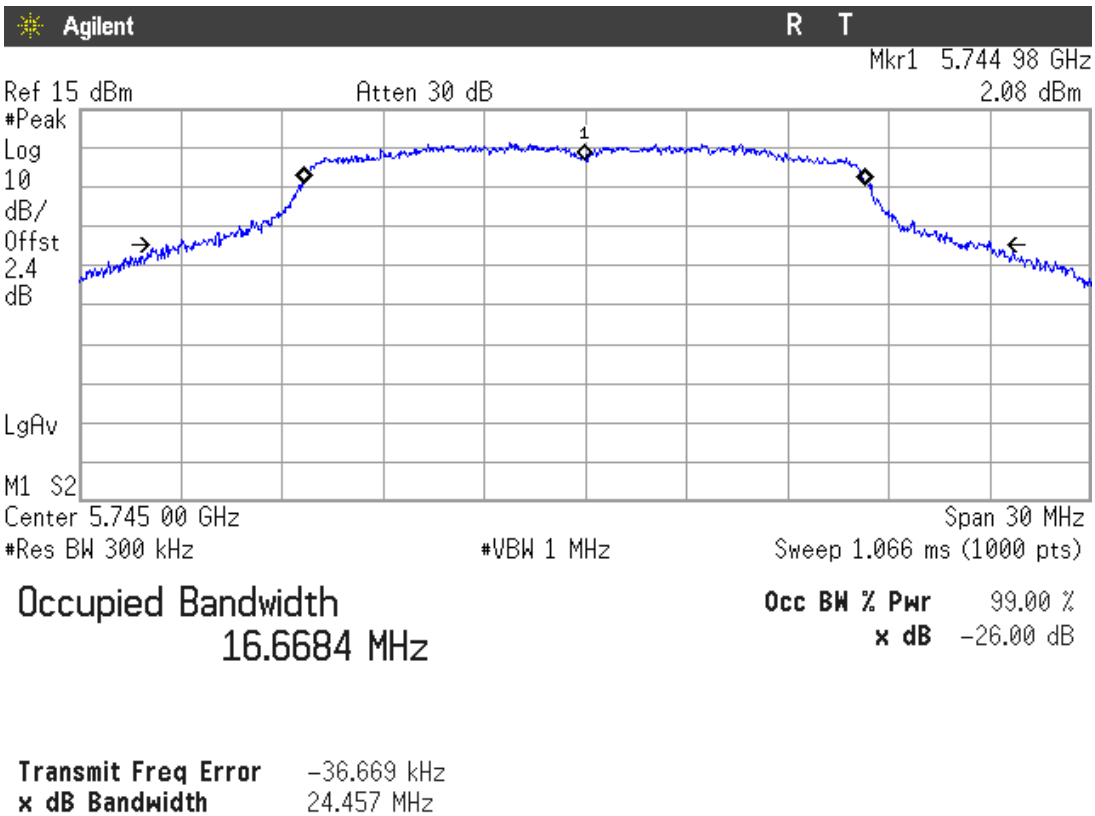
	Middle frequency 5775 MHz	
	Chain A	Chain B
99% bandwidth (MHz)	75.124	75.074
Measurement uncertainty (kHz)	±21.7	

1. WiFi 5GHz 802.11 a mode

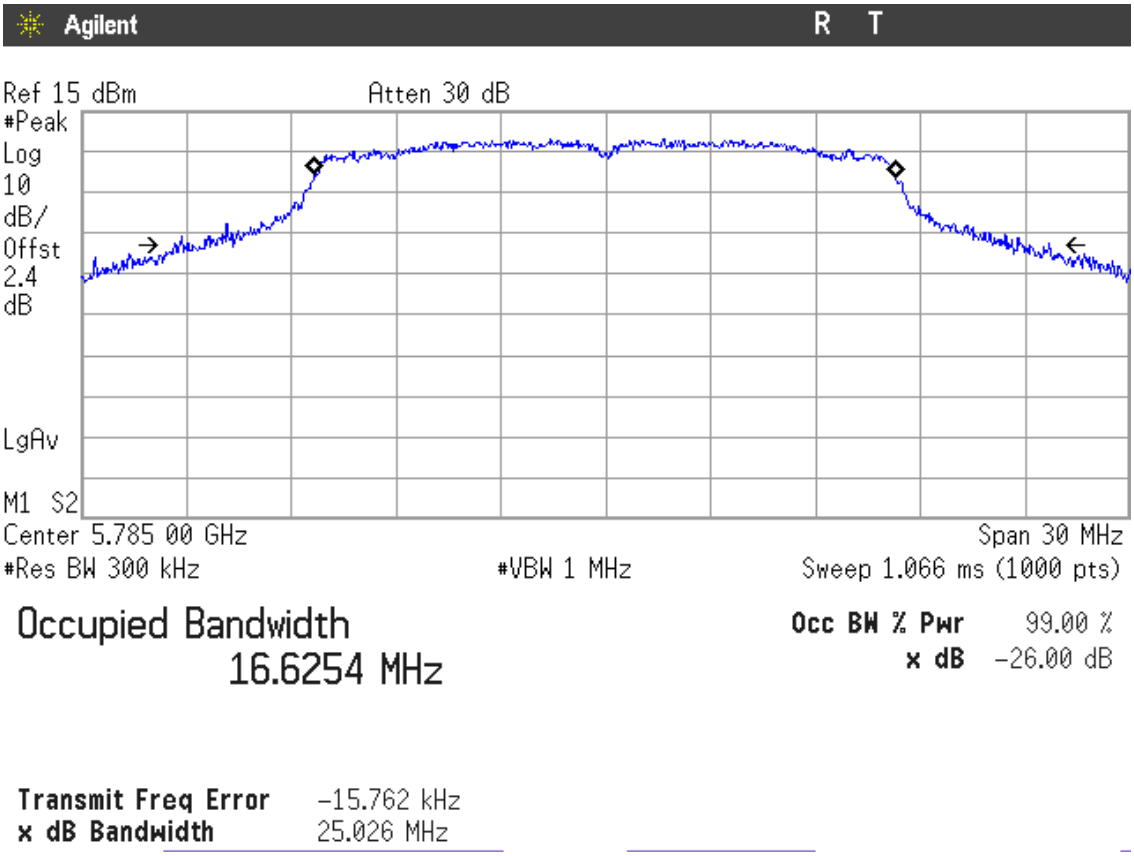
Lowest Channel: 5745 MHz. Chain A



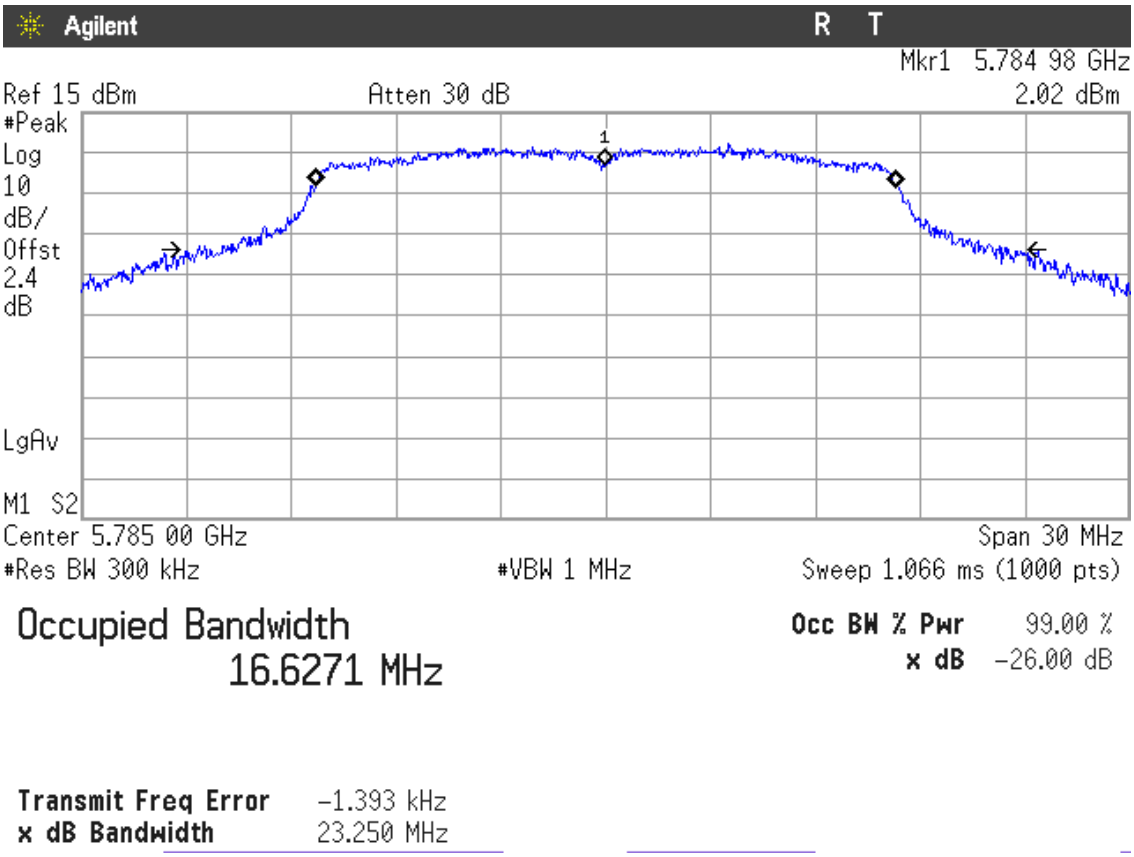
Lowest Channel: 5745 MHz. Chain B



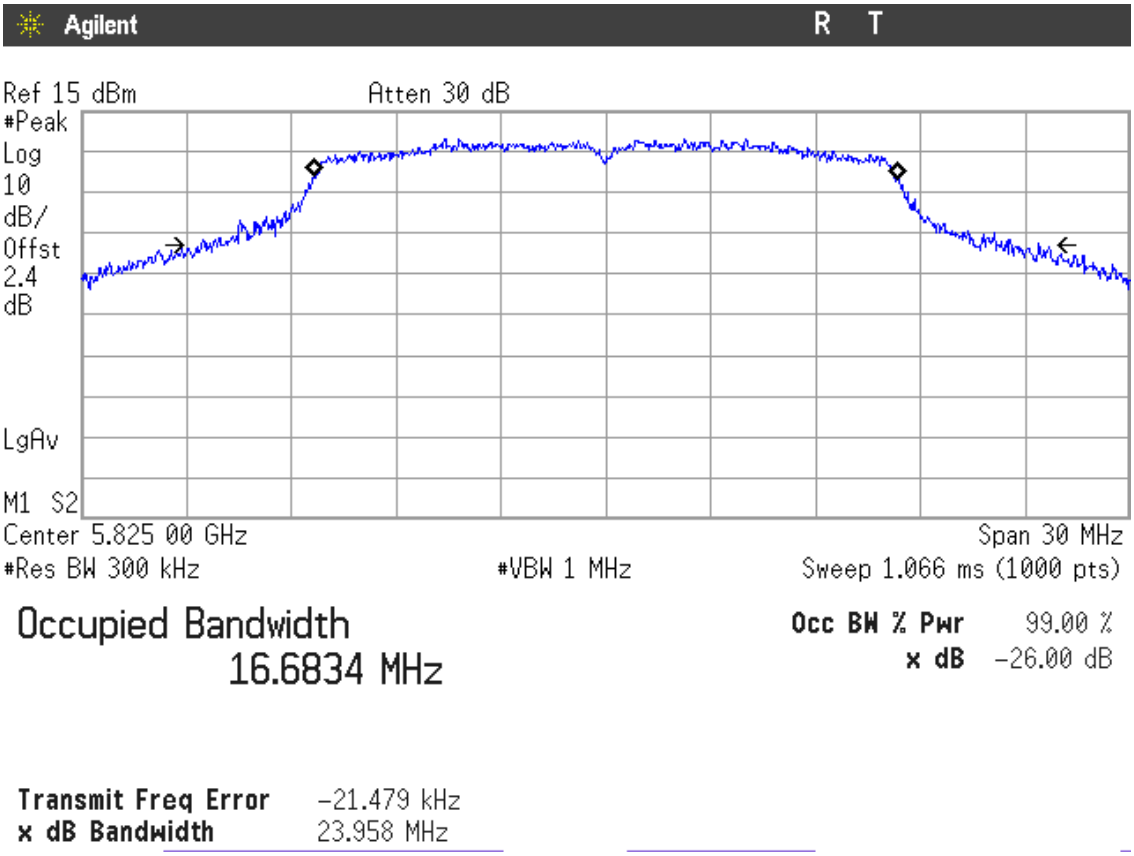
Middle Channel: 5785 MHz. Chain A



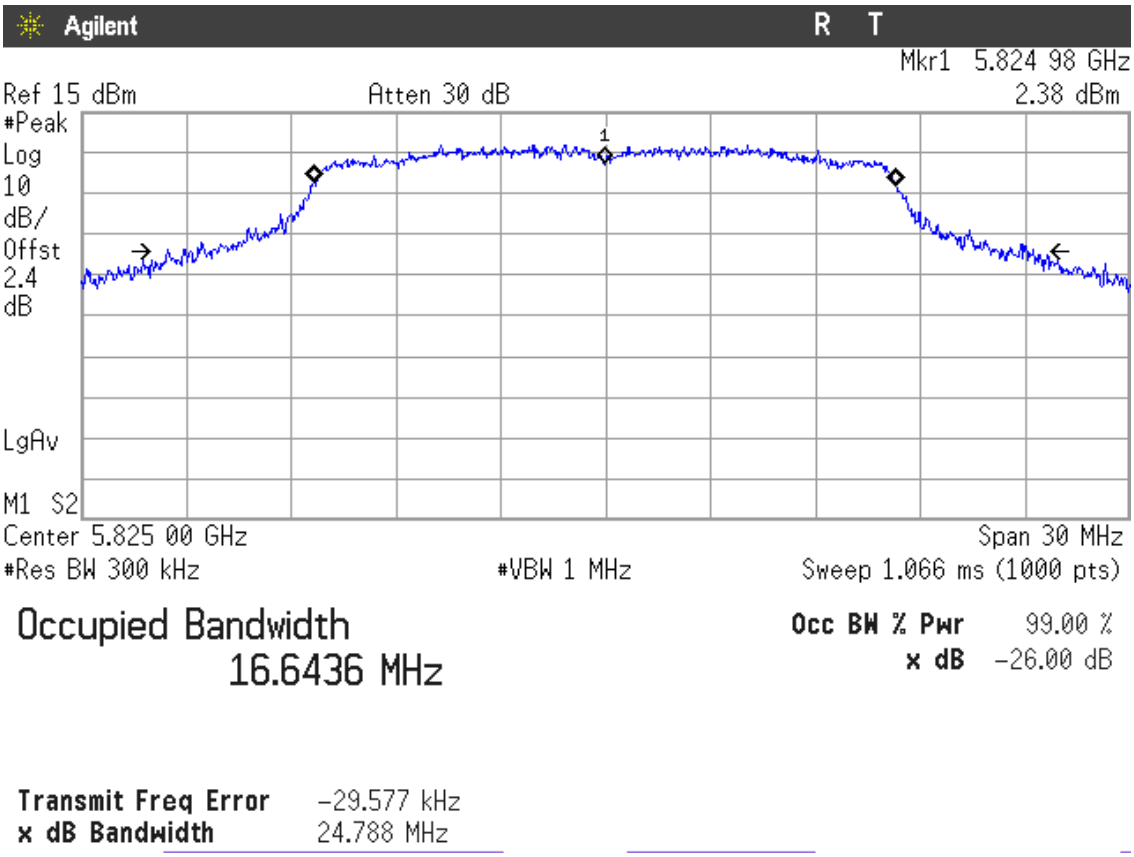
Middle Channel: 5785 MHz. Chain B



Highest Channel: 5825 MHz. Chain A

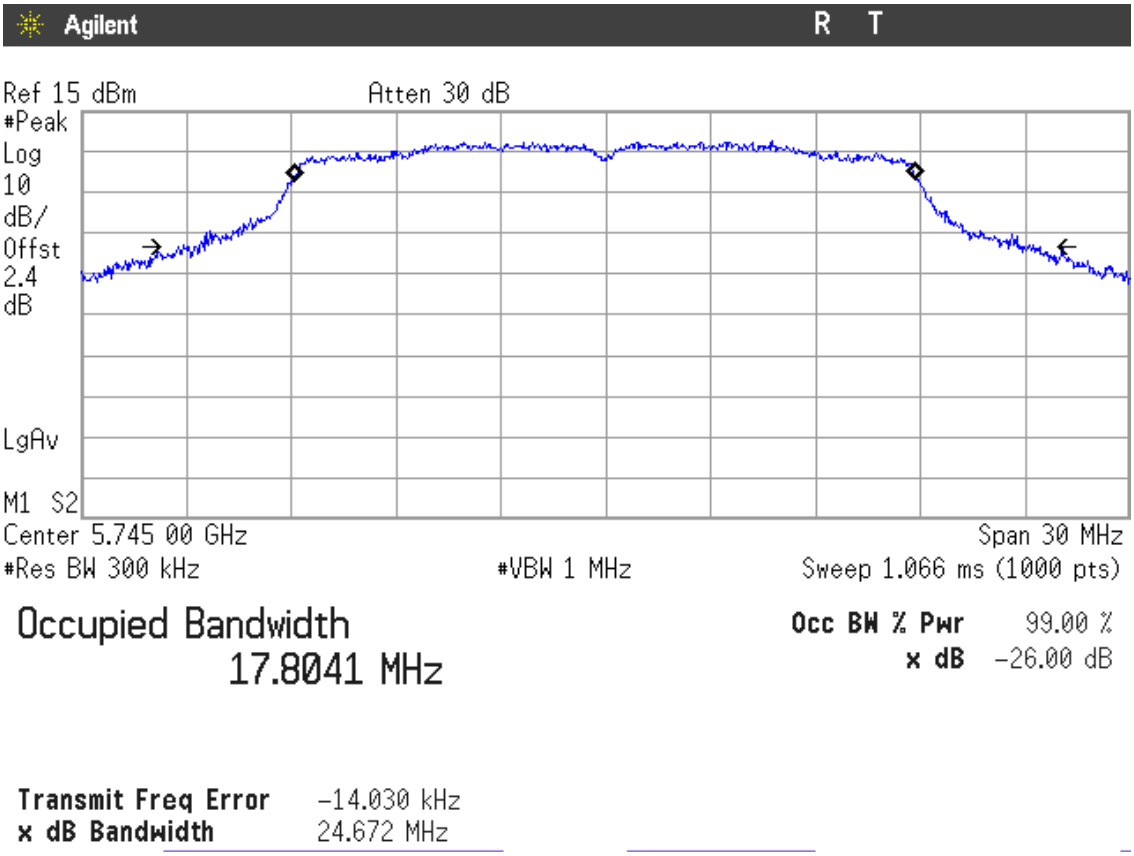


Highest Channel: 5825 MHz. Chain B

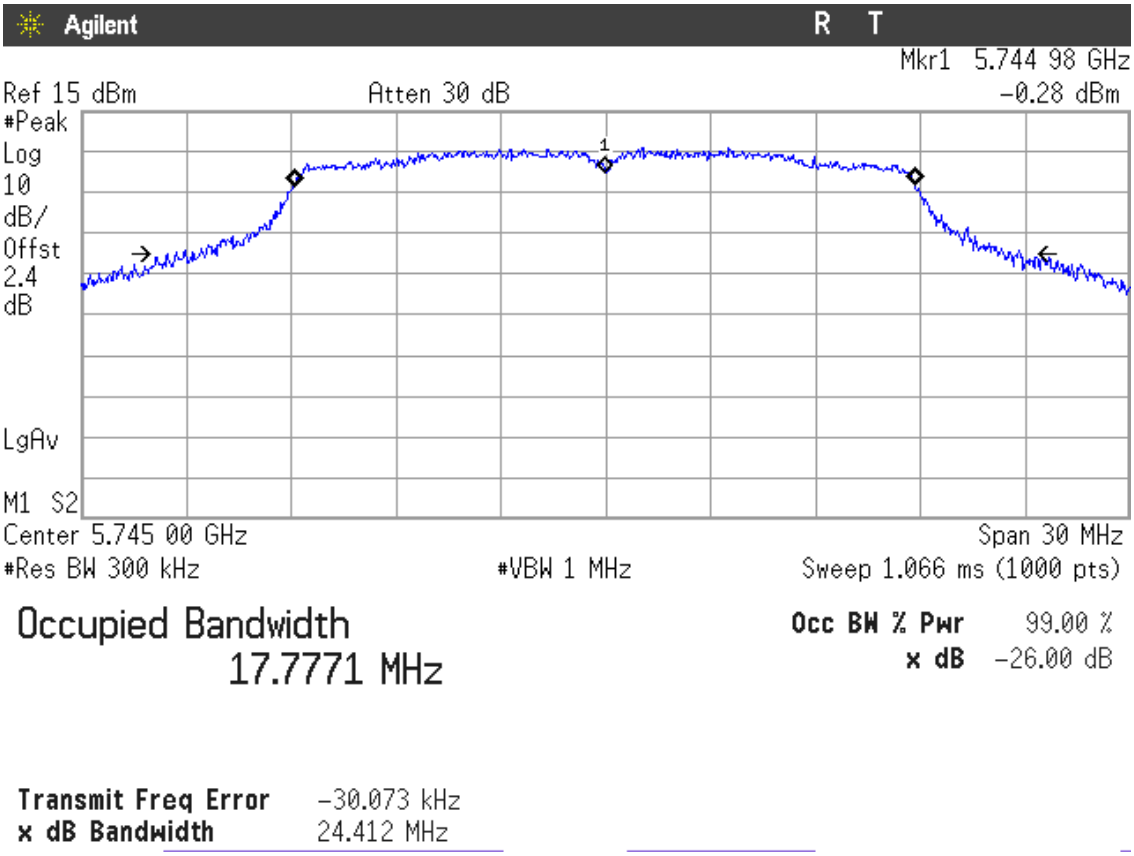


2. WiFi 5GHz 802.11 n20 mode

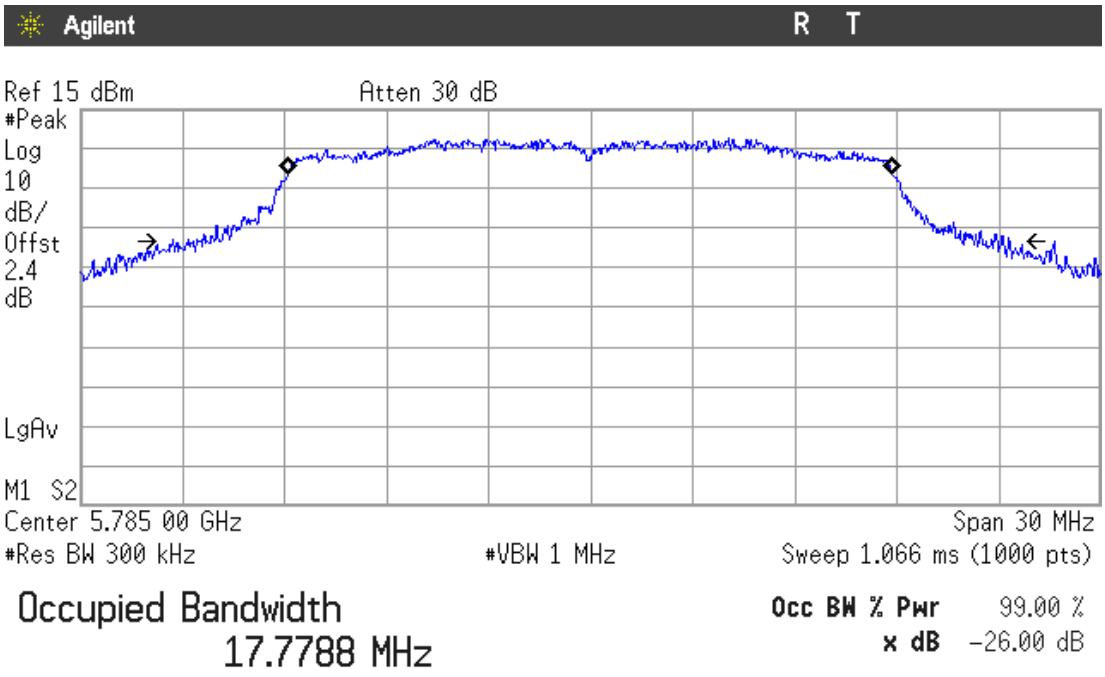
Lowest Channel: 5745 MHz. Chain A



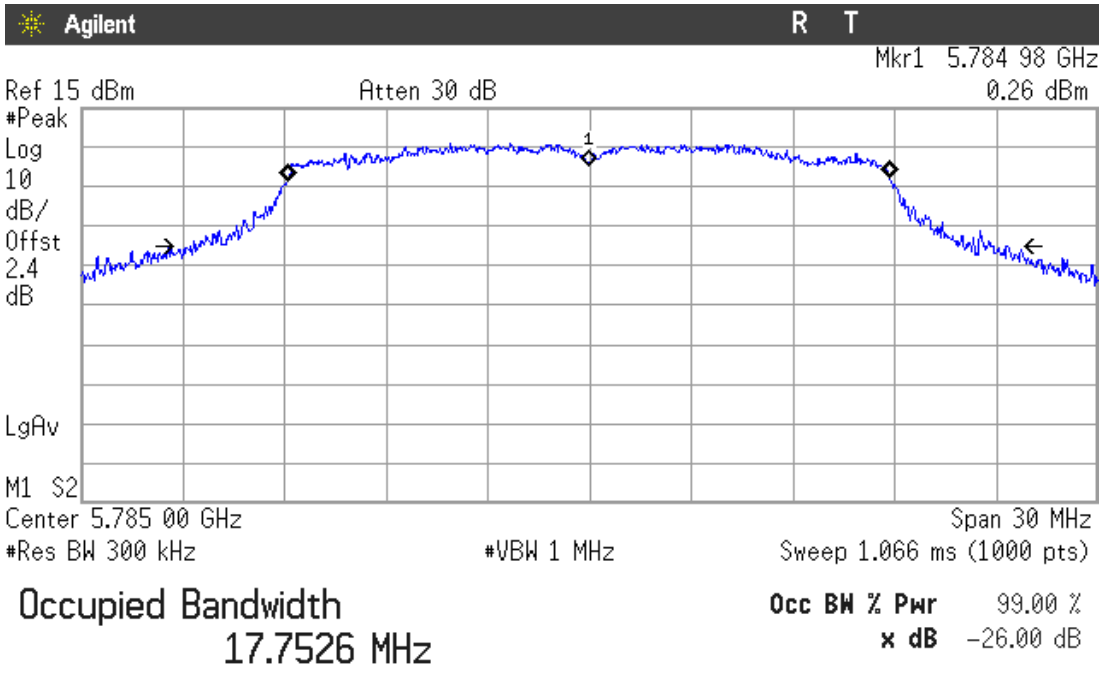
Lowest Channel: 5745 MHz. Chain B



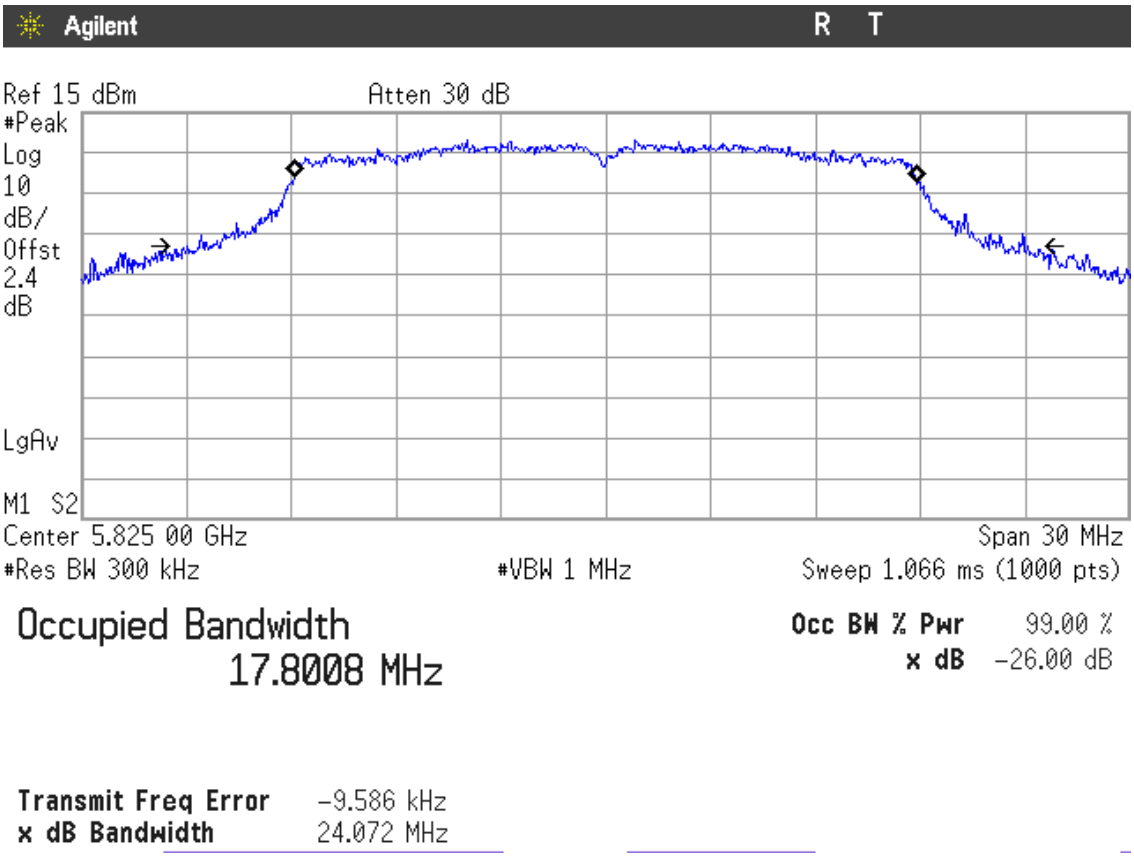
Middle Channel: 5785 MHz. Chain A



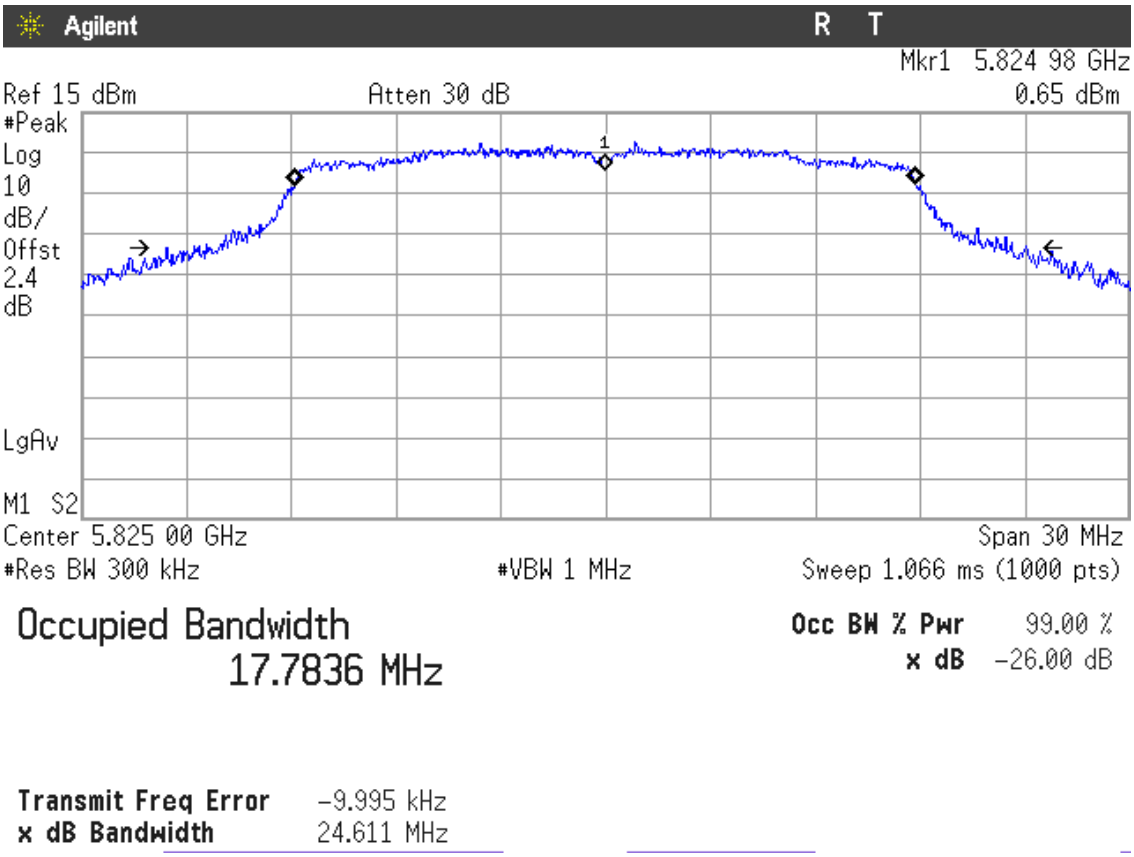
Middle Channel: 5785 MHz. Chain B



Highest Channel: 5825 MHz. Chain A

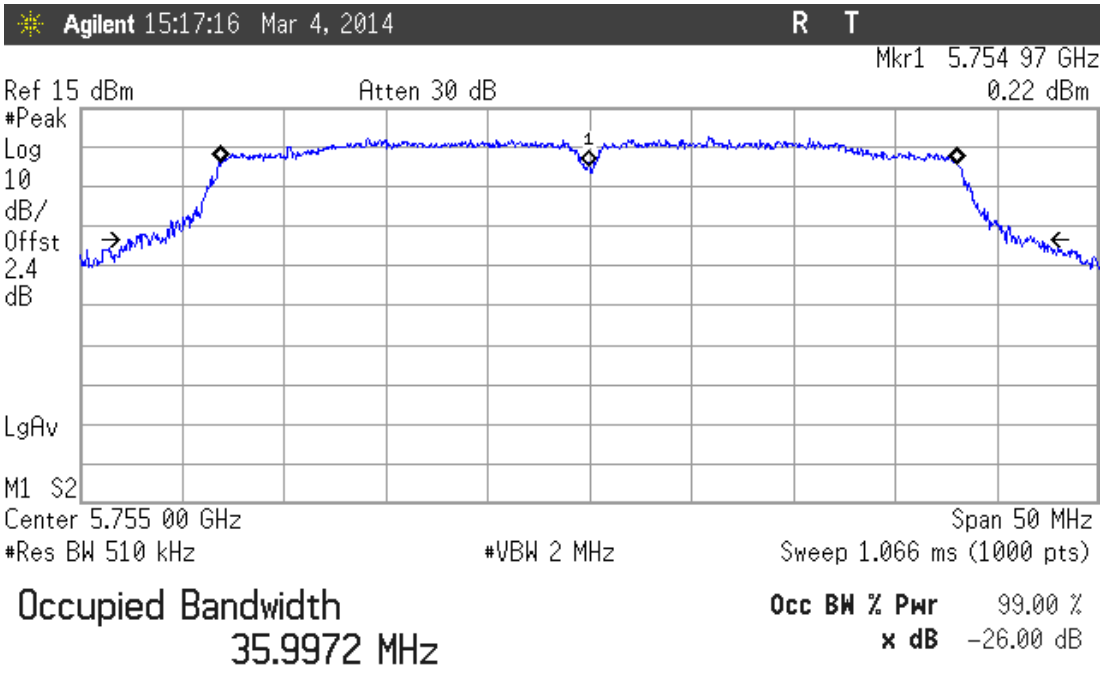


Highest Channel: 5825 MHz. Chain B

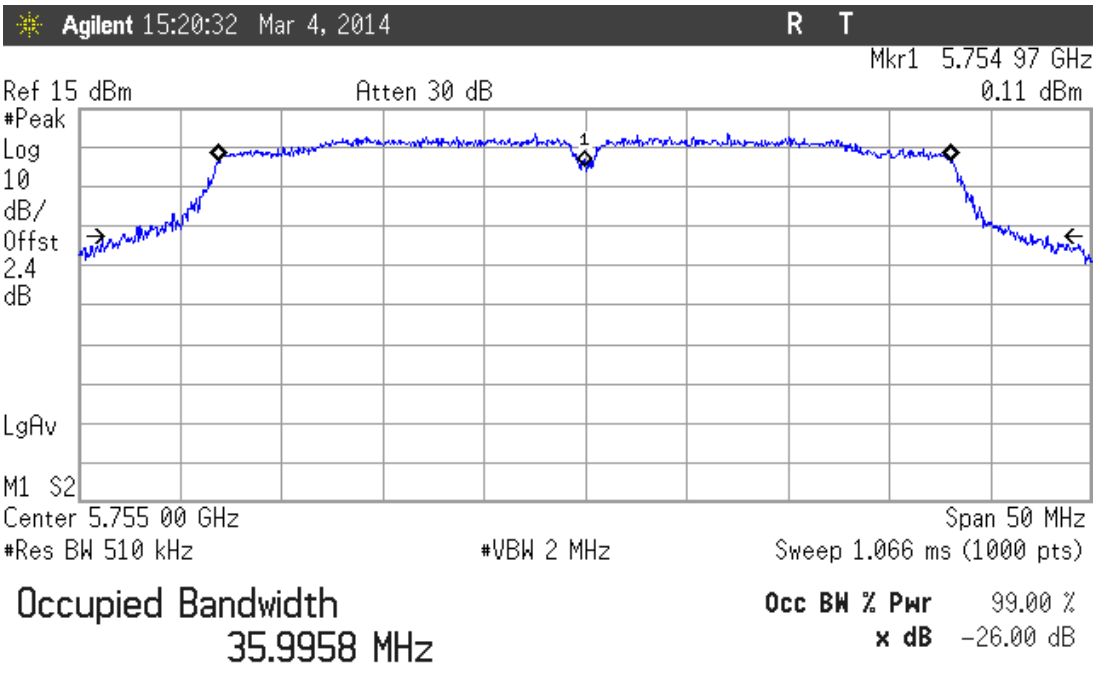


3. WiFi 5GHz 802.11 n40 mode

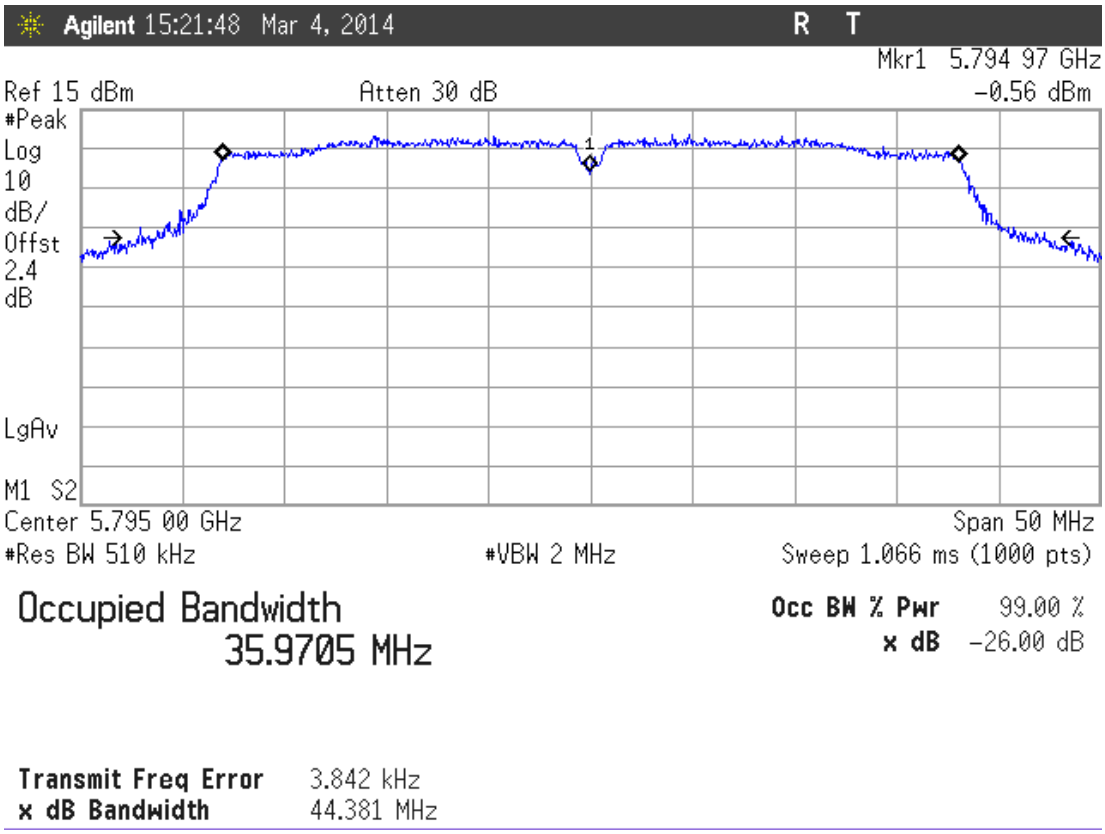
Lowest Channel: 5755 MHz. Chain A



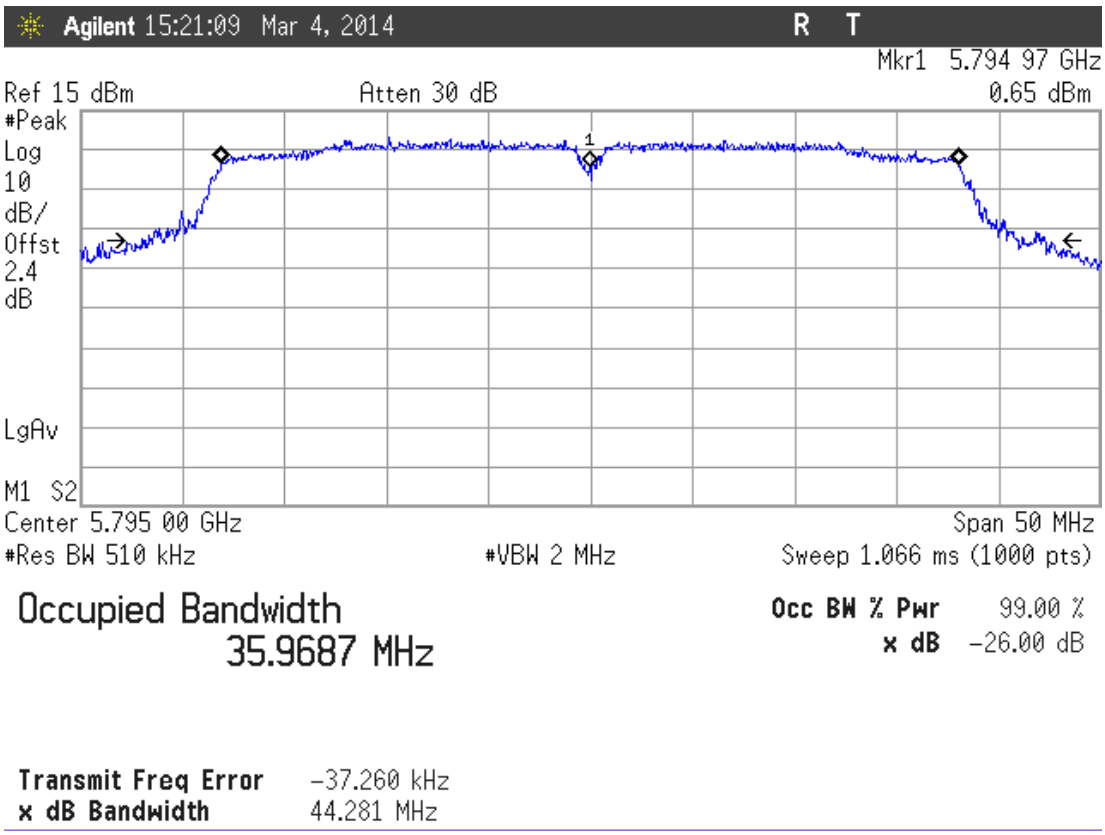
Lowest Channel: 5755 MHz. Chain B



Highest Channel: 5795 MHz. Chain A

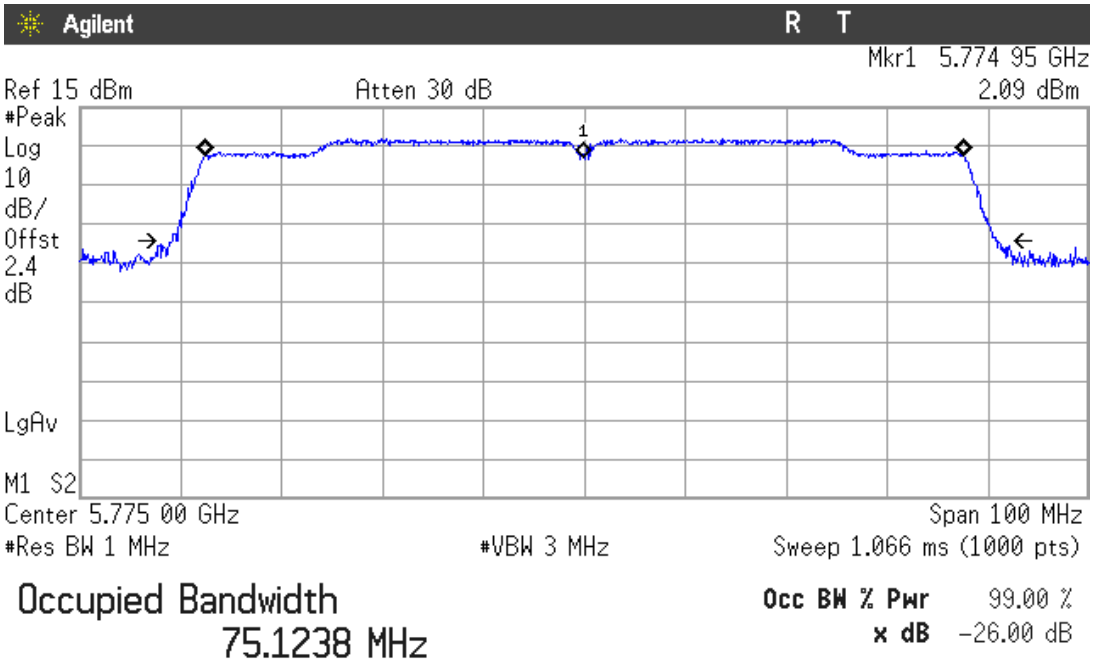


Highest Channel: 5795 MHz. Chain B

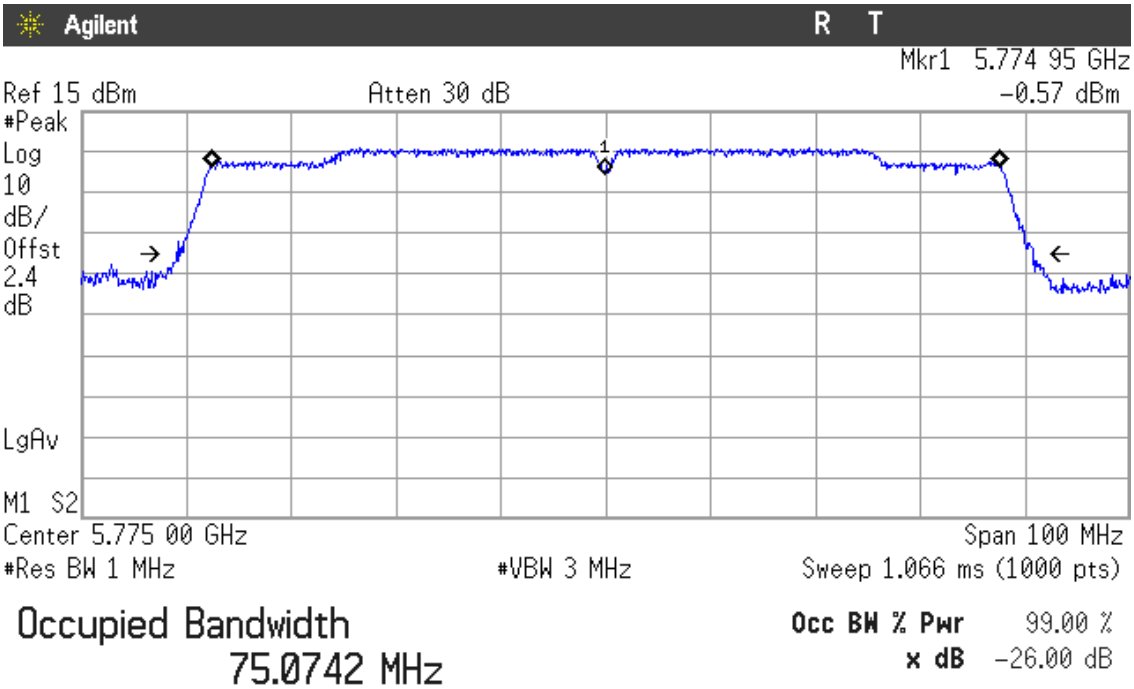


4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz. Chain A



Middle Channel: 5775 MHz. Chain B



Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a). 6 dB Bandwidth

SPECIFICATION

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

RESULTS

6 dB Bandwidth (see next plots).

1. WiFi 5GHz 802.11 a mode

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
6 dB Spectrum bandwidth (MHz)	15.160	15.353	15.321	15.160	15.128	15.128
Measurement uncertainty (kHz)	±89					

2. WiFi 5GHz 802.11 n20 mode

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
6 dB Spectrum bandwidth (MHz)	15.128	15.321	15.128	15.481	15.096	15.128
Measurement uncertainty (kHz)	±89					

3. WiFi 5GHz 802.11 n40 mode

	Lowest frequency 5755 MHz		Highest frequency 5795 MHz	
	Chain A	Chain B	Chain A	Chain B
6 dB Spectrum bandwidth (MHz)	35.128	35.128	35.128	35.128
Measurement uncertainty (kHz)	±21.7			

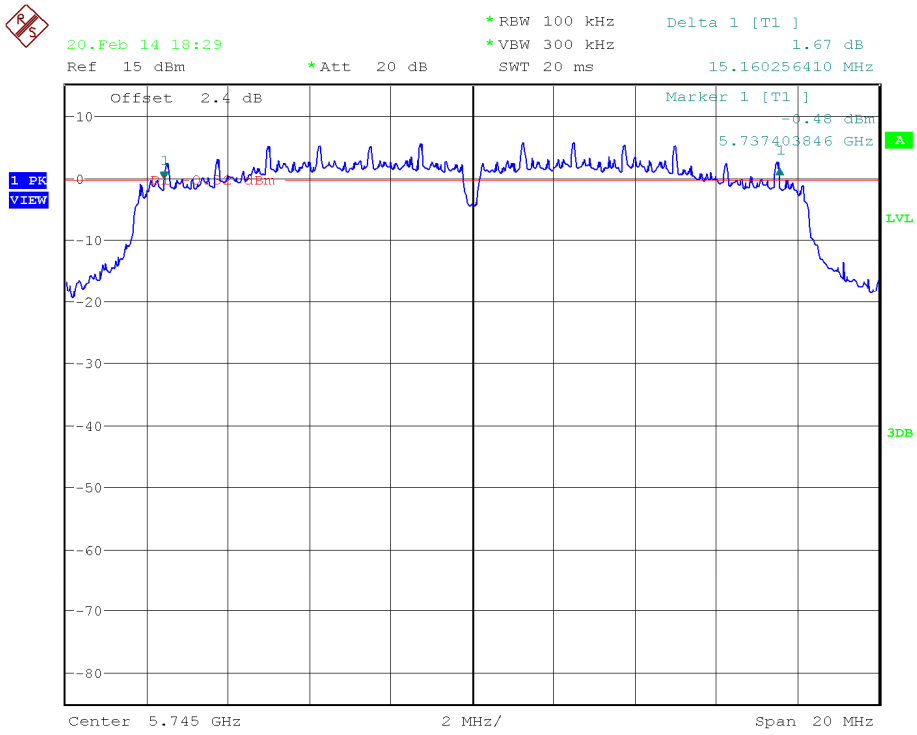
4. WiFi 5GHz 802.11 ac80 mode

	Middle frequency 5775 MHz	
	Chain A	Chain B
6 dB Spectrum bandwidth (MHz)	75.256	75.256
Measurement uncertainty (kHz)	±21.7	

Verdict: PASS

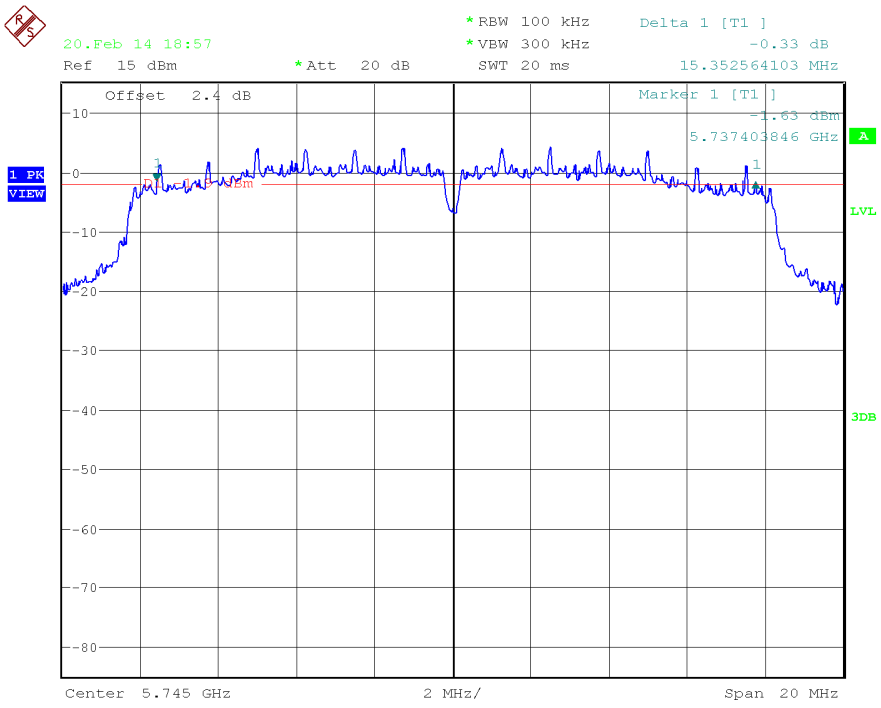
1. WiFi 5GHz 802.11 a mode

Lowest Channel: 5745 MHz. Chain A



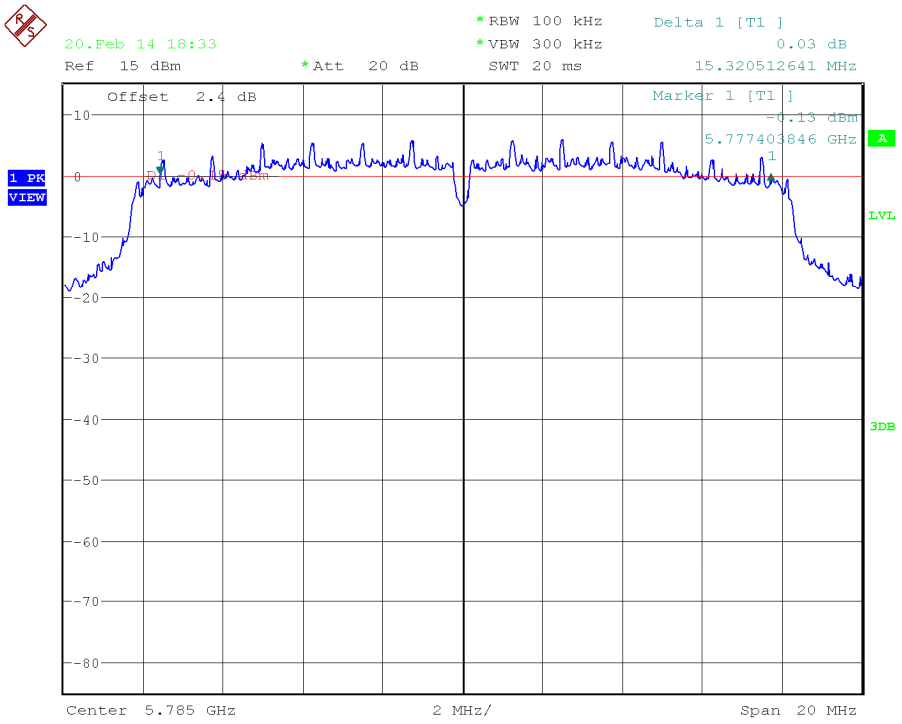
Date: 20.FEB.2014 18:29:34

Lowest Channel: 5745 MHz. Chain B



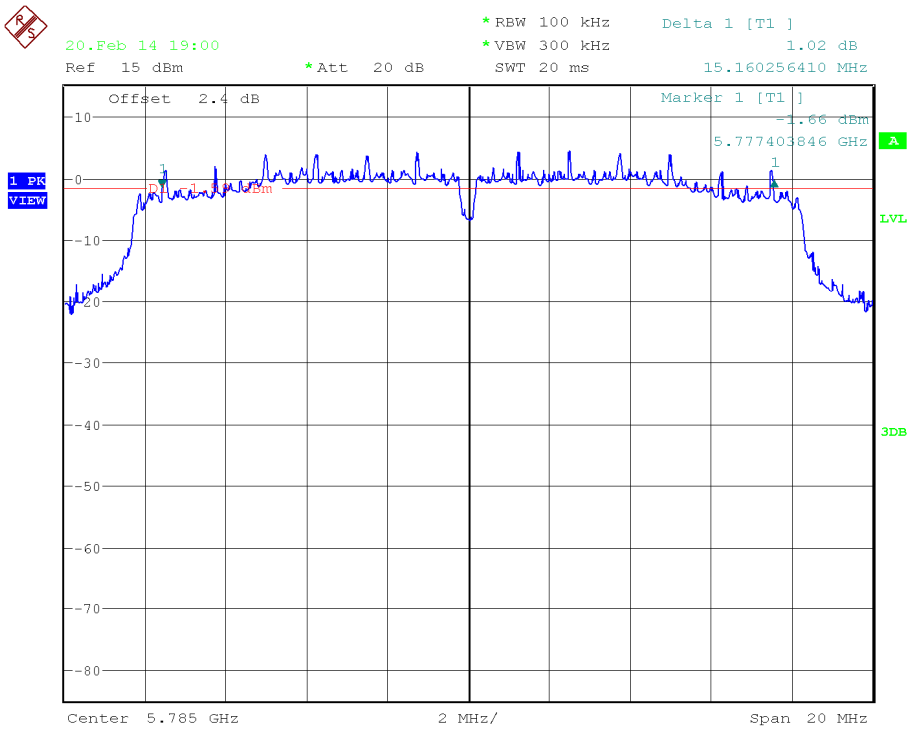
Date: 20.FEB.2014 18:57:40

Middle Channel: 5785 MHz. Chain A



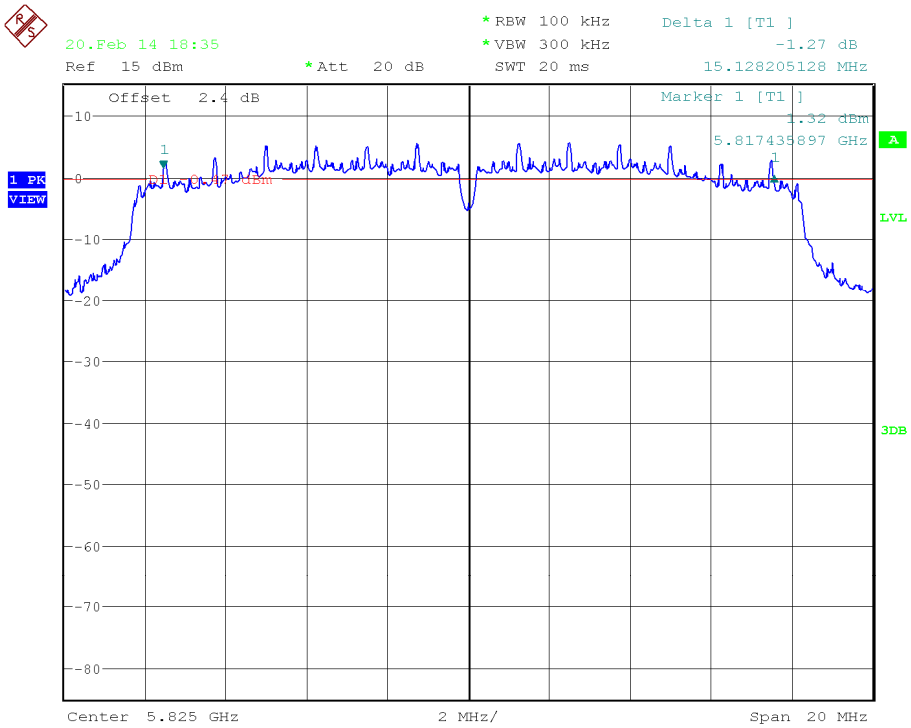
Date: 20.FEB.2014 18:33:04

Middle Channel: 5785 MHz. Chain B



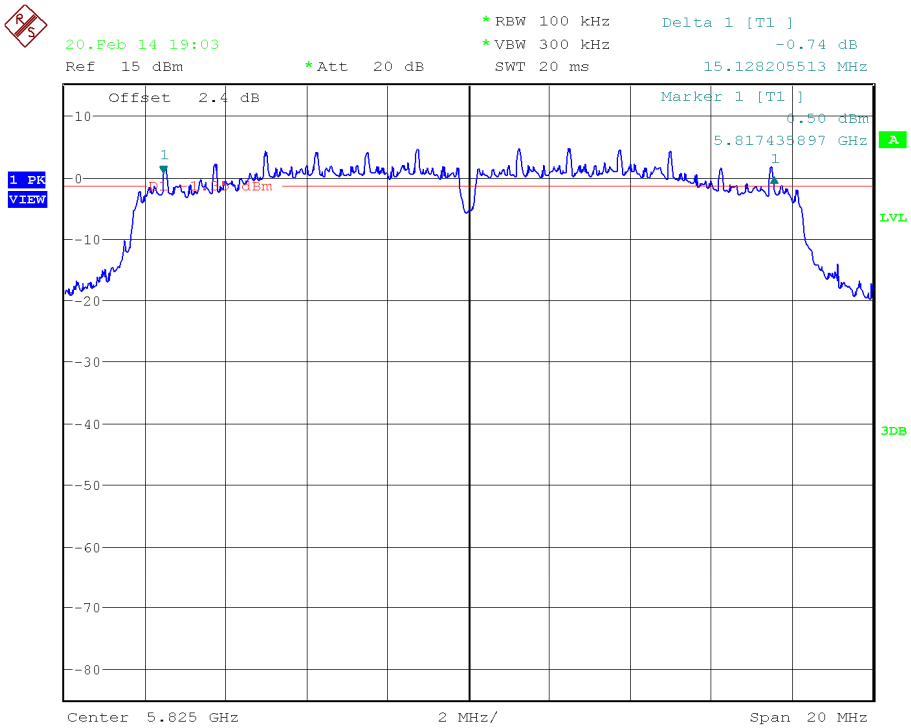
Date: 20.FEB.2014 19:00:45

Highest Channel: 5825 MHz. Chain A



Date: 20.FEB.2014 18:35:35

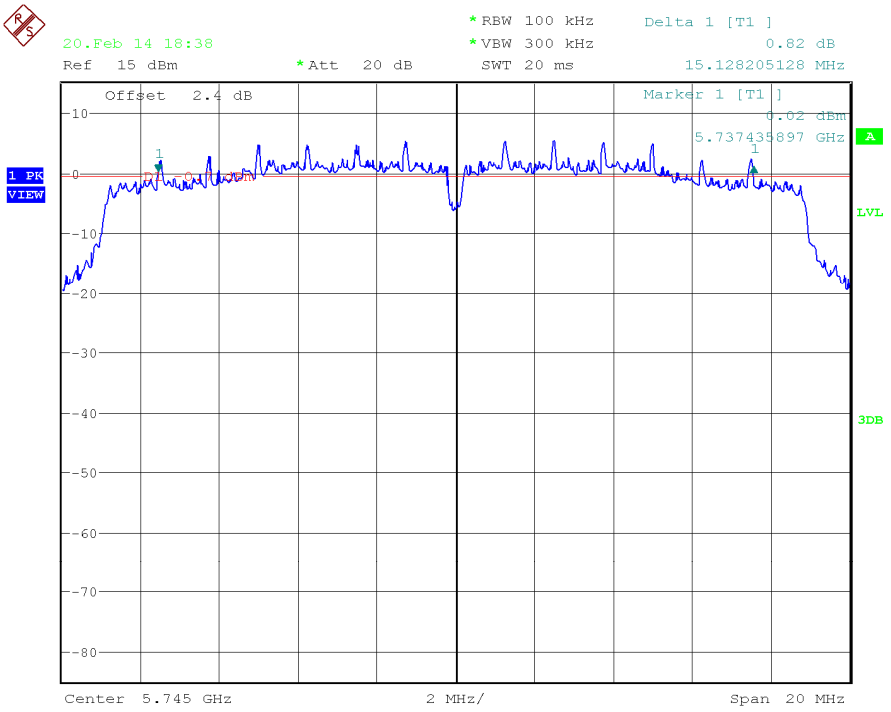
Highest Channel: 5825 MHz. Chain B



Date: 20.FEB.2014 19:03:18

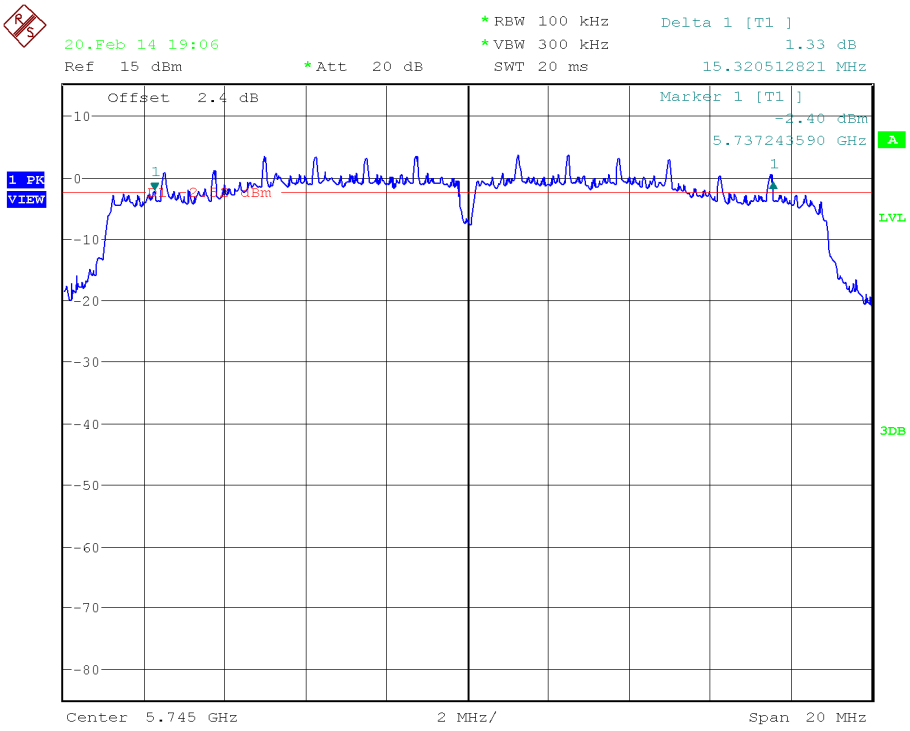
2. WiFi 5GHz 802.11 n20 mode

Lowest Channel: 5745 MHz. Chain A



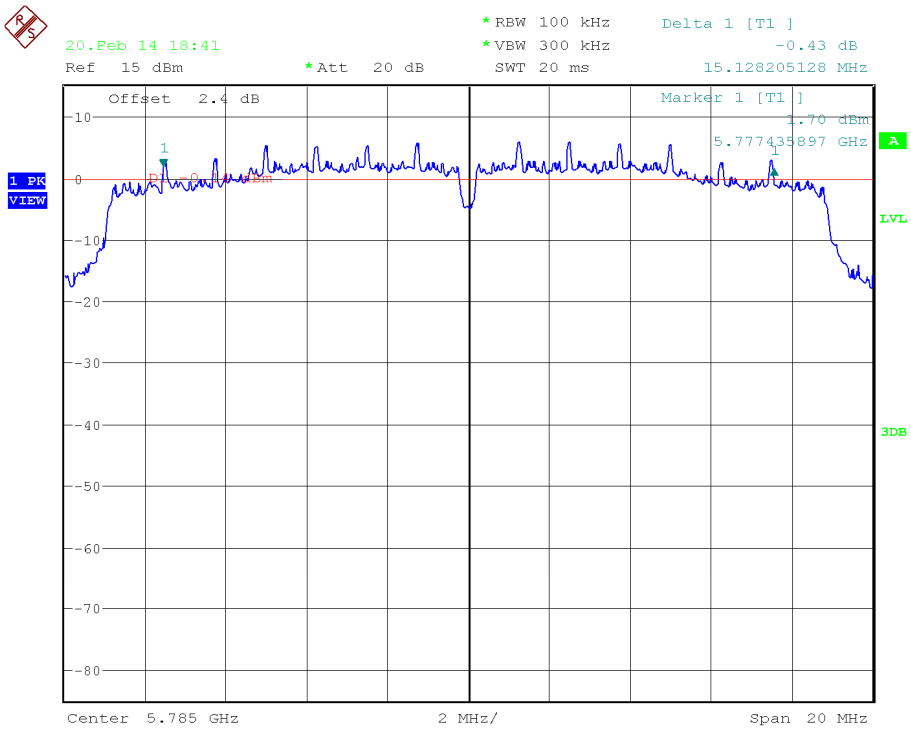
Date: 20.FEB.2014 18:38:30

Lowest Channel: 5745 MHz. Chain B



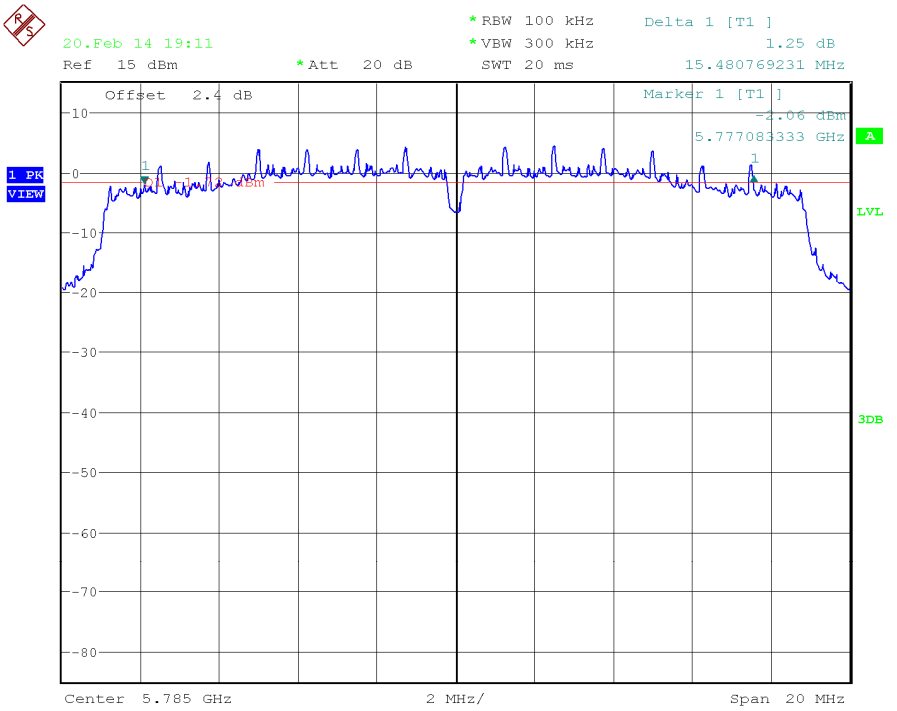
Date: 20.FEB.2014 19:06:51

Middle Channel: 5785 MHz. Chain A



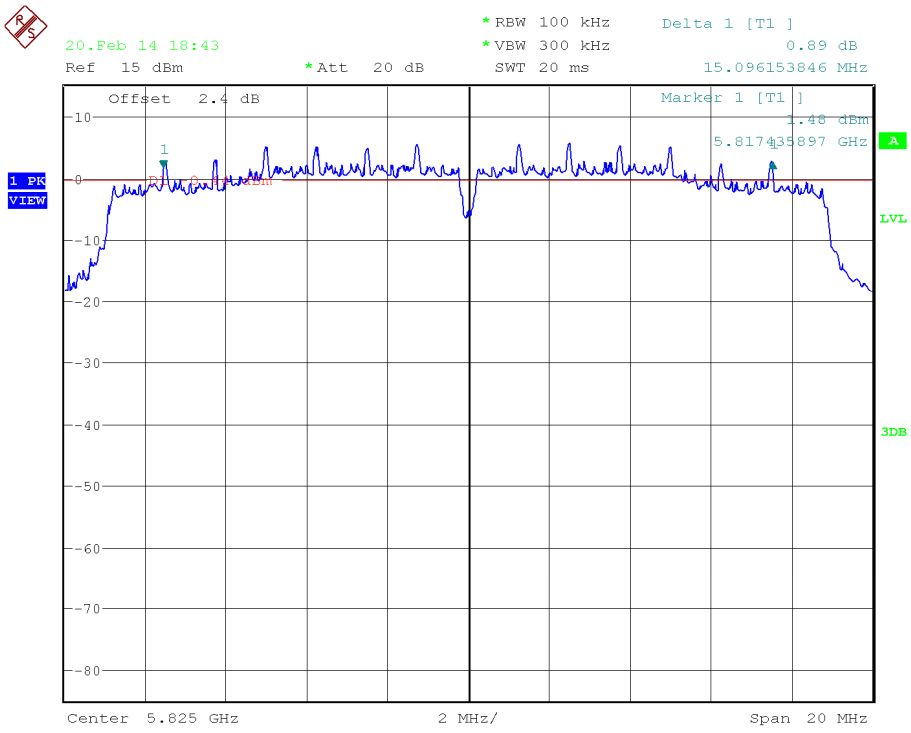
Date: 20.FEB.2014 18:41:41

Middle Channel: 5785 MHz. Chain B



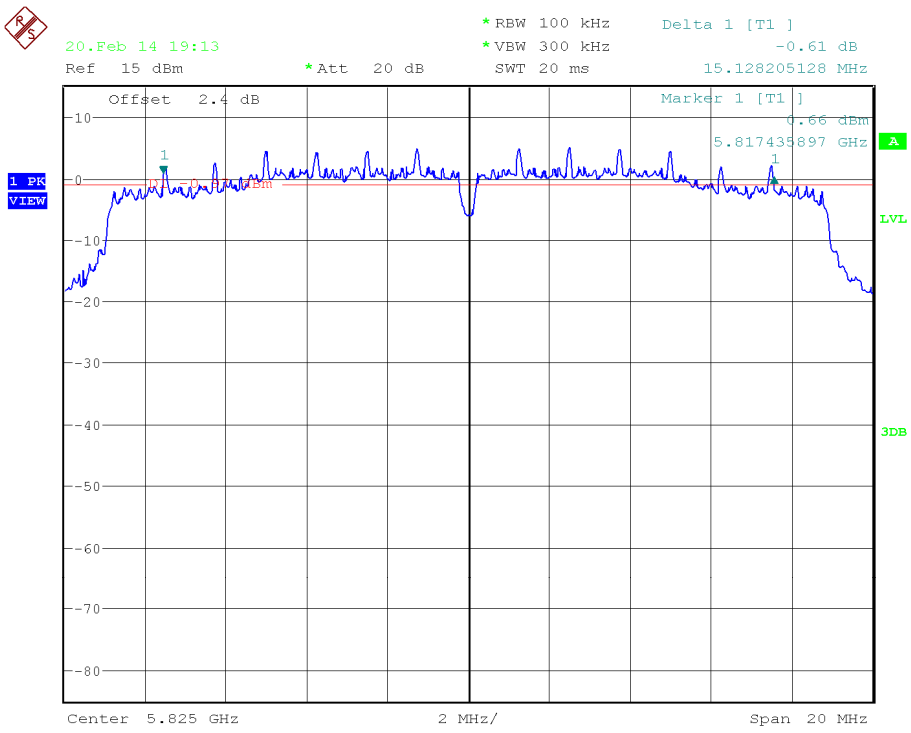
Date: 20.FEB.2014 19:11:10

Highest Channel: 5825 MHz. Chain A



Date: 20.FEB.2014 18:43:54

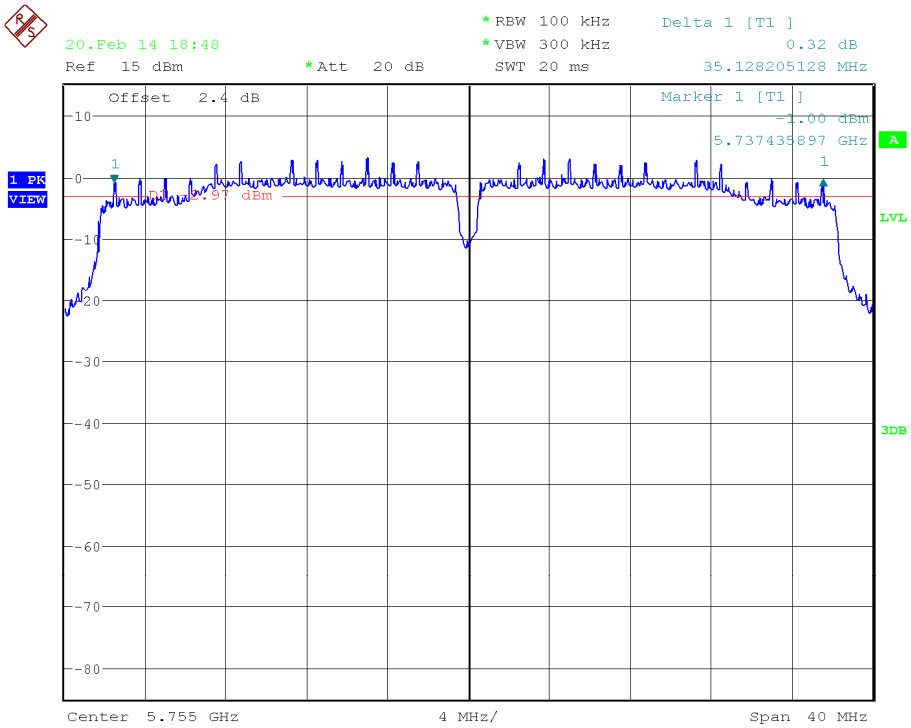
Highest Channel: 5825 MHz. Chain B



Date: 20.FEB.2014 19:13:39

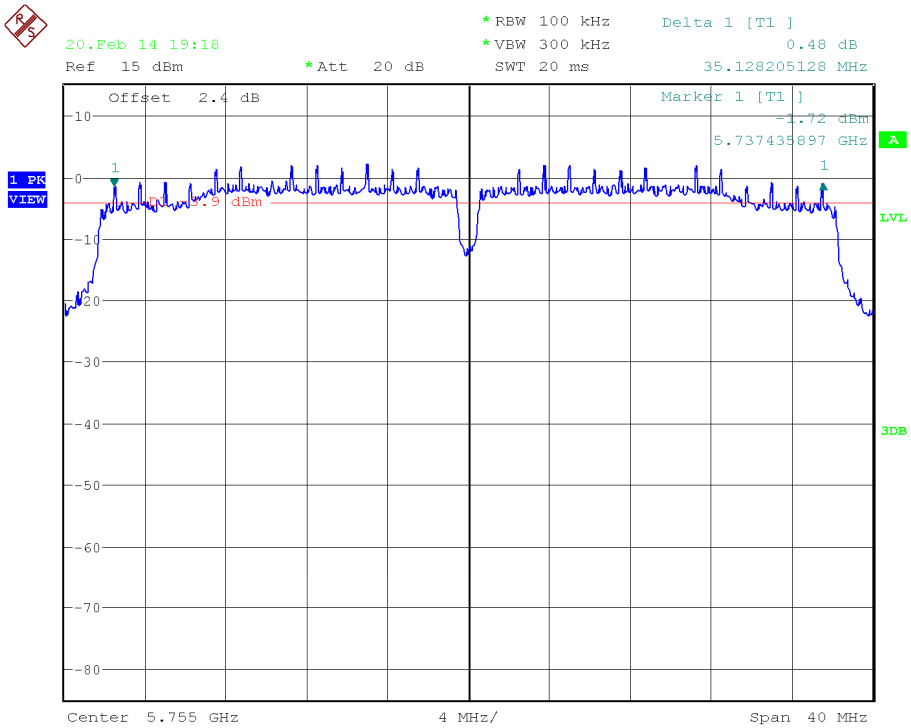
3. WiFi 5GHz 802.11 n40 mode

Lowest Channel: 5755 MHz. Chain A



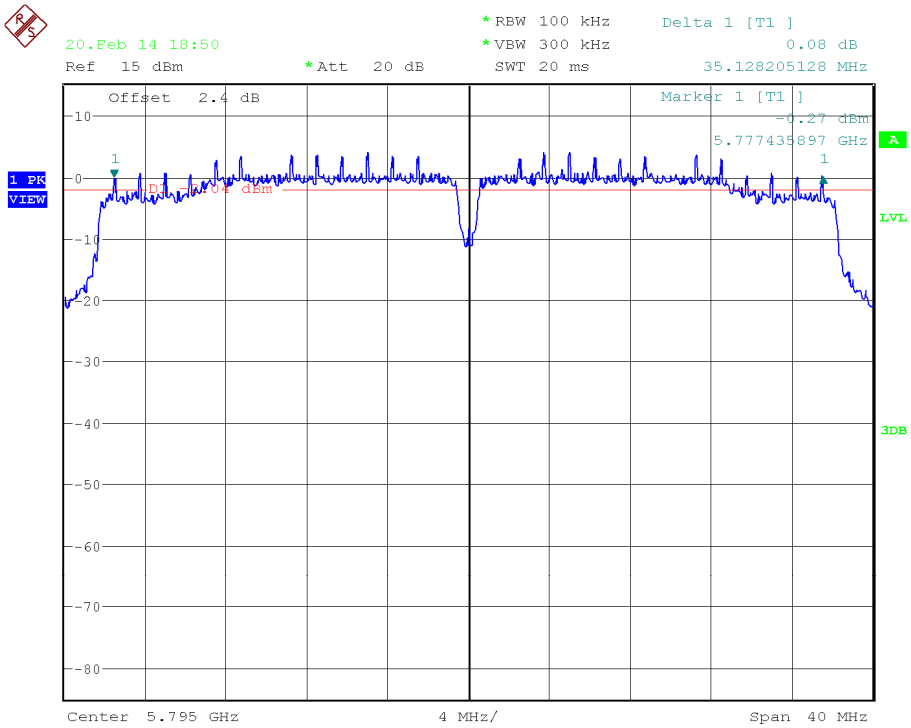
Date: 20.FEB.2014 18:48:00

Lowest Channel: 5755 MHz. Chain B



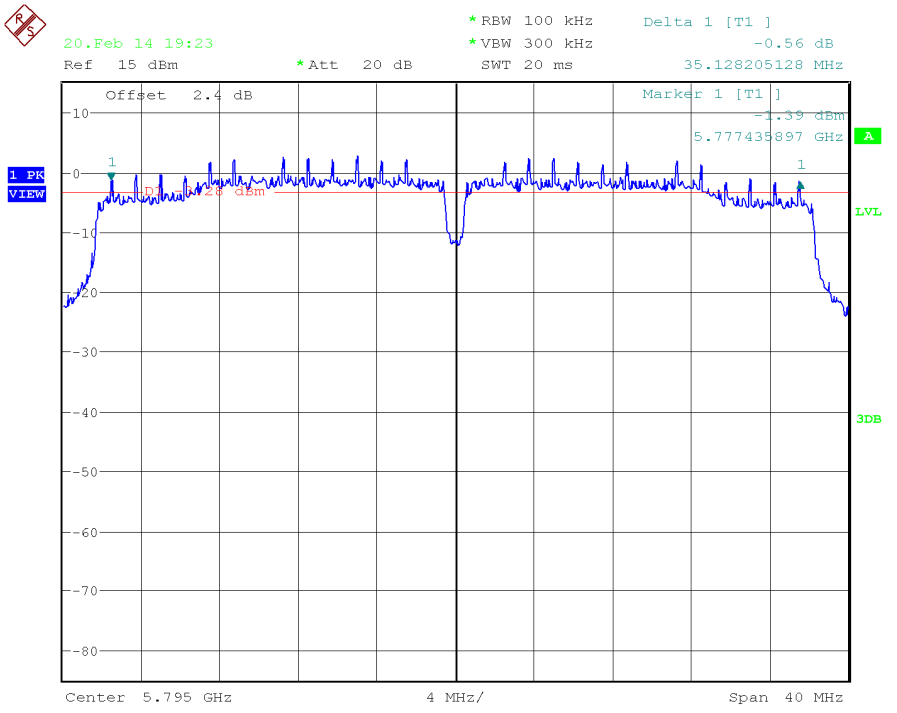
Date: 20.FEB.2014 19:18:53

Highest Channel: 5795 MHz. Chain A



Date: 20.FEB.2014 18:50:32

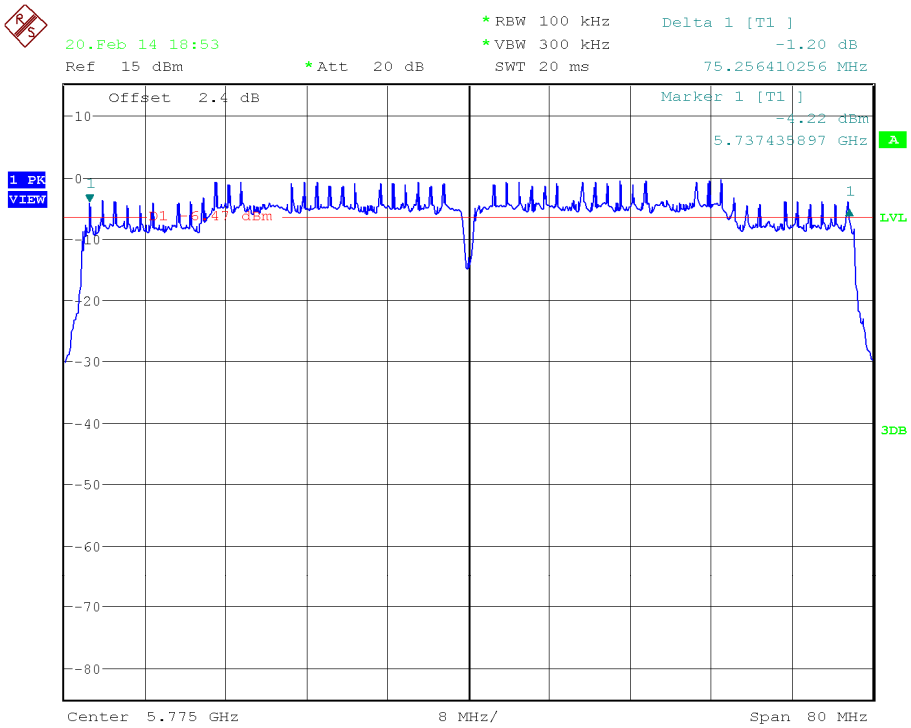
Highest Channel: 5795 MHz. Chain B



Date: 20.FEB.2014 19:23:00

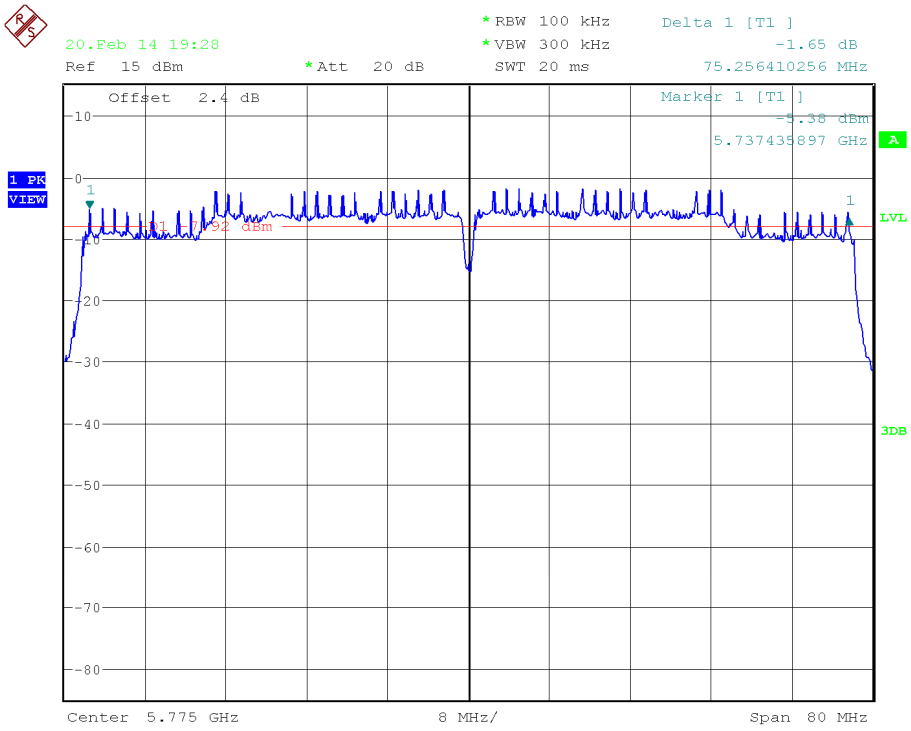
4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz. Chain A



Date: 20.FEB.2014 18:53:16

Middle Channel: 5775 MHz. Chain B



Date: 20.FEB.2014 19:28:25

Section 15.247 Subclause (b) / RSS-210 A8.4. (4). Maximum output power and antenna gain

SPECIFICATION

The maximum peak conducted output power of the intentional radiator shall not exceed 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS

The maximum Peak Conducted Output Power was measured using the channel integration method according to point 9.1.2. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r01 dated 09/04/2013. This method was used for 802.11ac80 mode.

The maximum conducted (average) output power was measured using the method according to point 9.2.1.2. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r01 dated 09/04/2013. This method was used for 802.11a, 802.11n20 and 802.11n40 modes.

In the measure-and-sum approach for MIMO mode, the conducted emission level (*e.g.*, transmit power or power in specified bandwidth) is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units (mW—not dBm).

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

For MIMO mode, the Guidance on directional Gain calculations according to the Guidance for Emission Testing of Transmitters with Multiple Outputs in the Same Band 662911 D01 Multiple Transmitter Output v02r01 dated 10/31/2013 was used.
The number of transmit antennas (N_{ANT}) are 2 and the number of spatial streams (Nss) are 2 and therefore the Array Gain is 0 dB.

MAXIMUM OUTPUT POWER. (See next plots of worst case: highest power).

Declared maximum antenna gain: 5 dBi.

1. WiFi 5GHz 802.11 a mode

Conducted (average) output power.

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
Maximum conducted power (dBm)	15.27	15.02	15.67	14.70	15.42	15.35
Maximum EIRP power (dBm)	20.27	20.02	20.67	19.70	20.42	20.35
Measurement uncertainty (dB)	±1.5					

2. WiFi 5GHz 802.11 n20 mode

Conducted (average) output power.

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
Maximum conducted power (dBm)	15.49	15.13	15.26	14.88	15.36	14.89
Maximum EIRP power (dBm)	20.49	20.13	20.26	19.88	20.36	19.89
Measurement uncertainty (dB)	±1.5					

MIMO	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A+B		Chain A+B		Chain A+B	
	Port A	Port B	Port A	Port B	Port A	Port B
Maximum conducted power (dBm)	13.49	13.19	13.18	13.20	13.36	13.74
	Port A+B		Port A+B		Port A+B	
Maximum conducted power (dBm)	16.35		16.20		16.56	
Maximum EIRP power (dBm)	21.35		21.20		21.56	
Measurement uncertainty (dB)	±1.5					

3. WiFi 5GHz 802.11 n40 mode

Conducted (average) output power.

	Lowest frequency 5755 MHz		Highest frequency 5795 MHz	
	Chain A	Chain B	Chain A	Chain B
Maximum conducted power (dBm)	16.29	16.21	16.29	16.15
Maximum EIRP power (dBm)	21.29	21.21	21.29	21.15
Measurement uncertainty (dB)	±1.5			

MIMO	Lowest frequency 5755 MHz		Highest frequency 5795 MHz	
	Chain A+B		Chain A+B	
	Port A	Port B	Port A	Port B
Maximum conducted power (dBm)	16.50	16.51	16.47	16.42
	Port A+B		Port A+B	
Maximum conducted power (dBm)	19.52		19.46	
Maximum EIRP power (dBm)	24.52		24.46	
Measurement uncertainty (dB)	±1.2			

Verdict: PASS

4. WiFi 5GHz 802.11 ac80 mode

Peak Conducted Output Power.

	Middle frequency 5775 MHz	
	Chain A	Chain B
Maximum conducted power (dBm)	24.96	25.19
Maximum EIRP power (dBm)	29.96	30.19
Measurement uncertainty (dB)	±1.2	

MIMO	Middle frequency 5775 MHz	
	Chain A+B	
	Port A	Port B
Maximum conducted power (dBm)	24.82	25.42
	Port A+B	
Maximum conducted power (dBm)	28.14	
Maximum EIRP power (dBm)	33.14	
Measurement uncertainty (dB)	±1.2	

Verdict: PASS

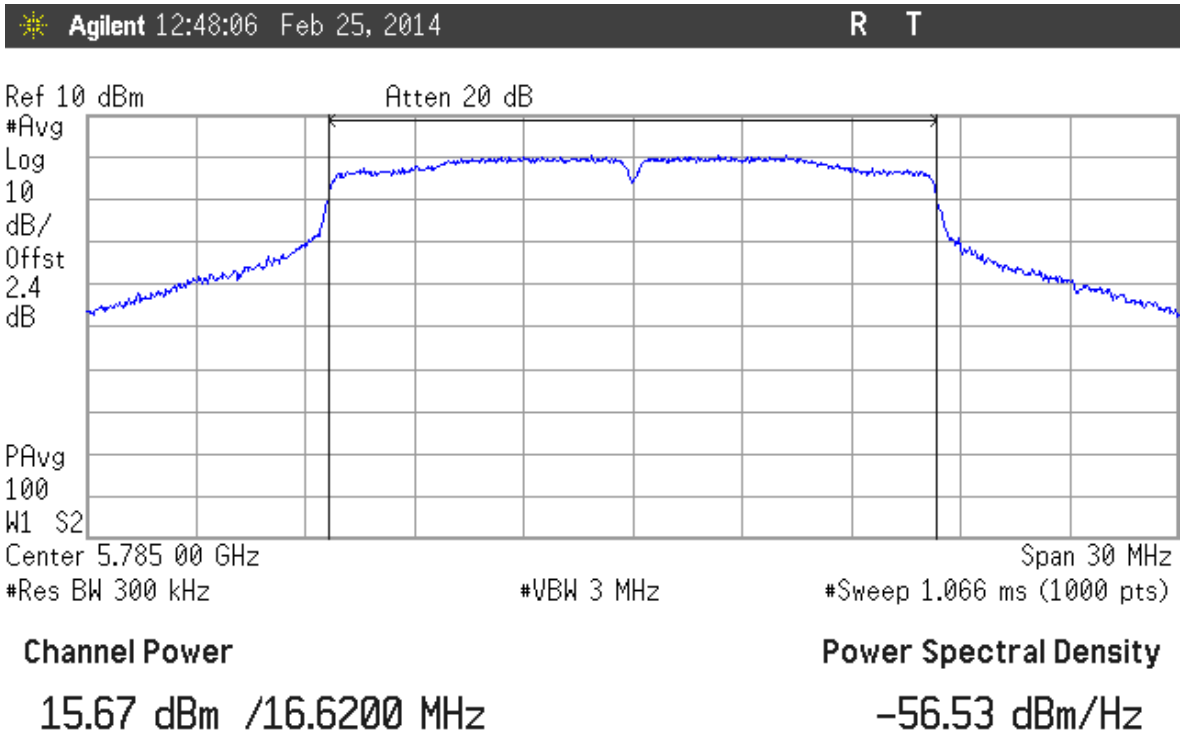
Conducted (average) output power. These results are for information purposes only.

	Middle frequency 5775 MHz	
	Chain A	Chain B
Maximum conducted power (dBm)	16.42	16.63
Maximum EIRP power (dBm)	21.42	21.63
Measurement uncertainty (dB)	±1.2	

MIMO	Middle frequency 5775 MHz	
	Chain A+B	
	Port A	Port B
Maximum conducted power (dBm)	16.51	16.55
	Port A+B	
Maximum conducted power (dBm)	19.54	
Maximum EIRP power (dBm)	24.54	
Measurement uncertainty (dB)	±1.2	

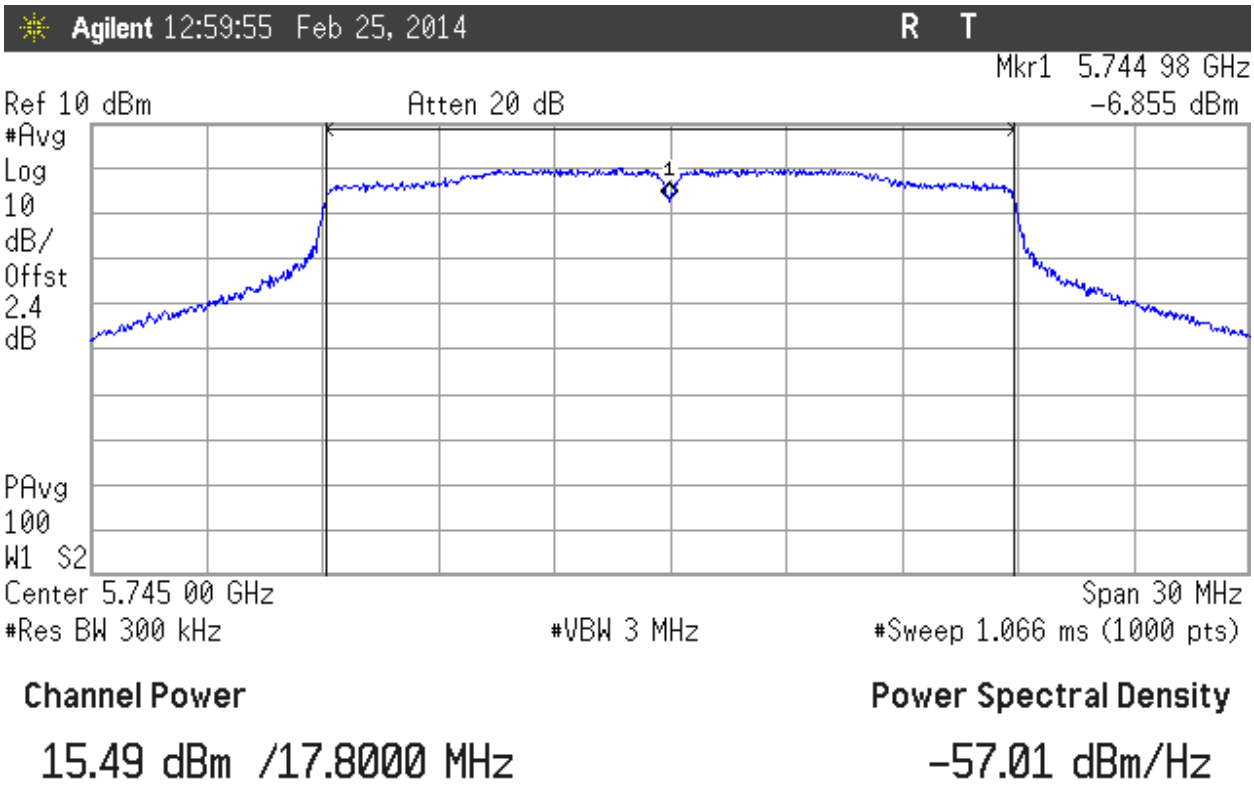
1. WiFi 5GHz 802.11 a mode

Middle Channel: 5785 MHz. Chain A

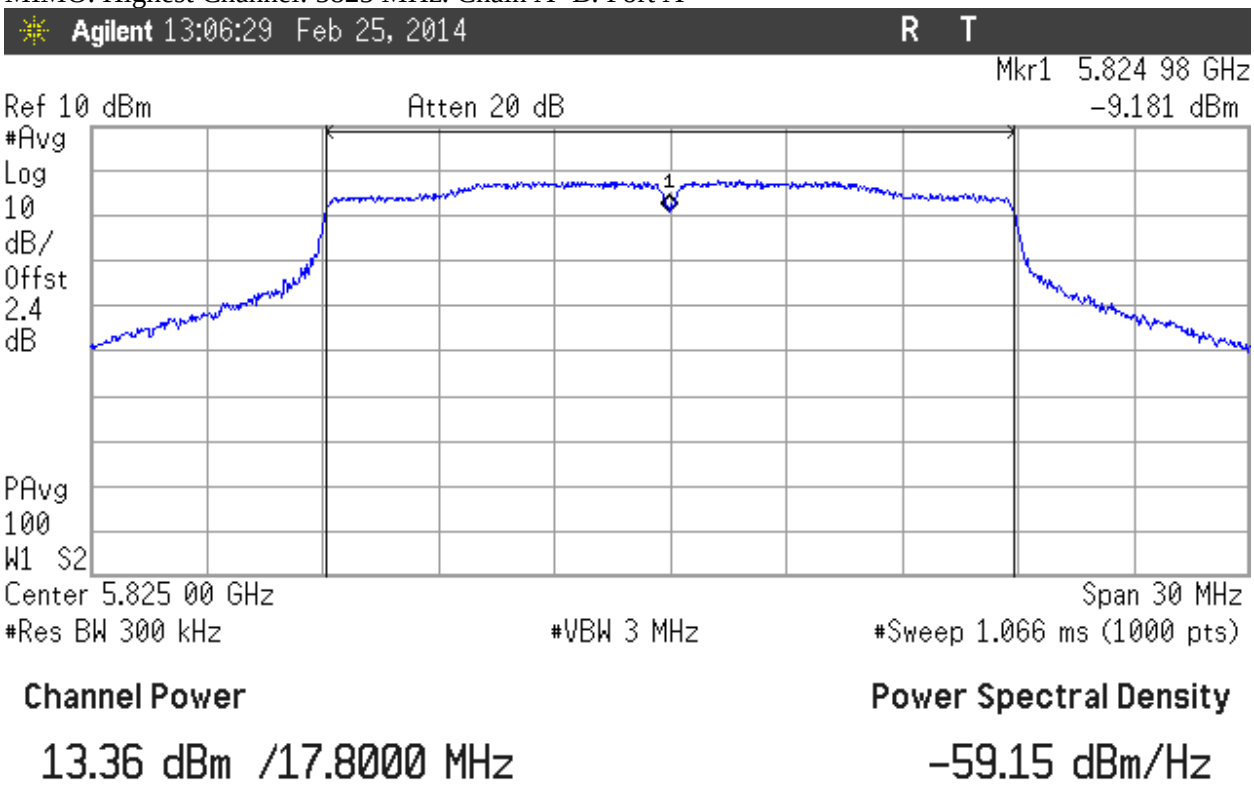


2. WiFi 5GHz 802.11 n20 mode

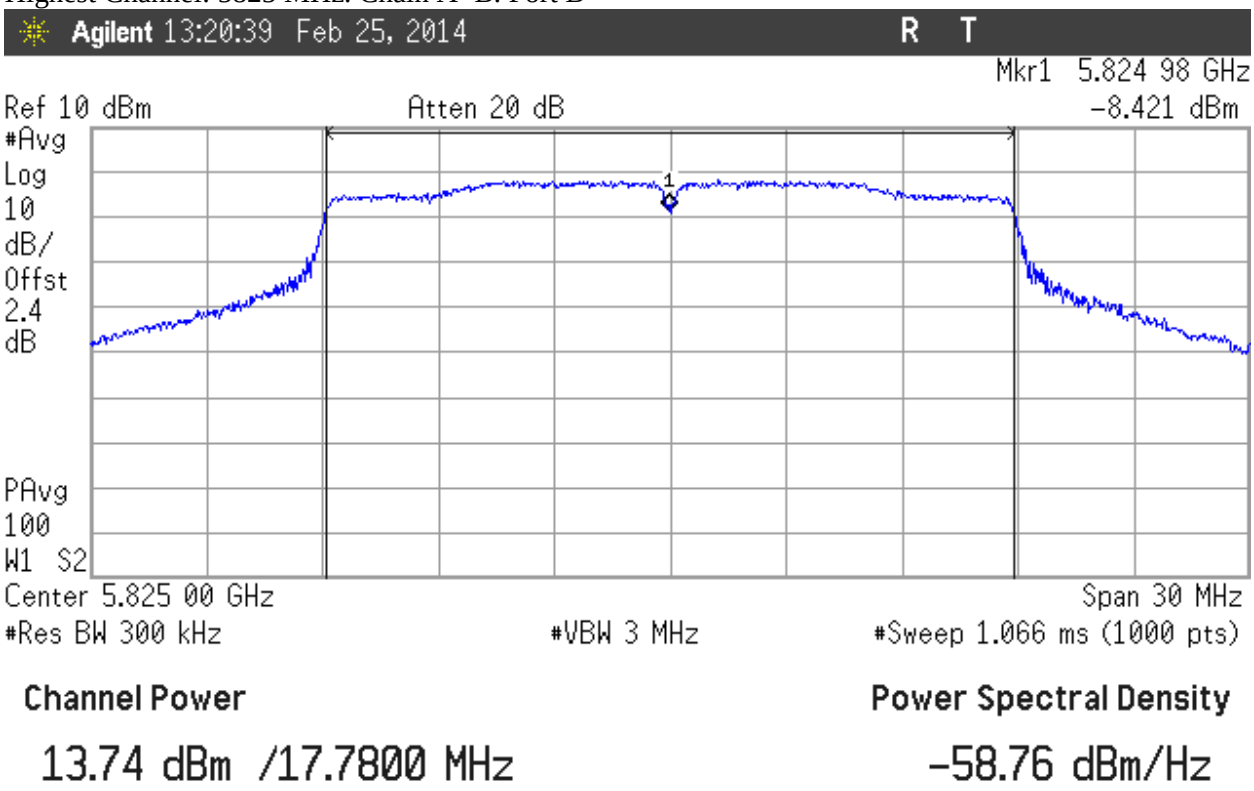
SISO. Lowest Channel: 5745 MHz. Chain A



MIMO. Highest Channel: 5825 MHz. Chain A+B. Port A

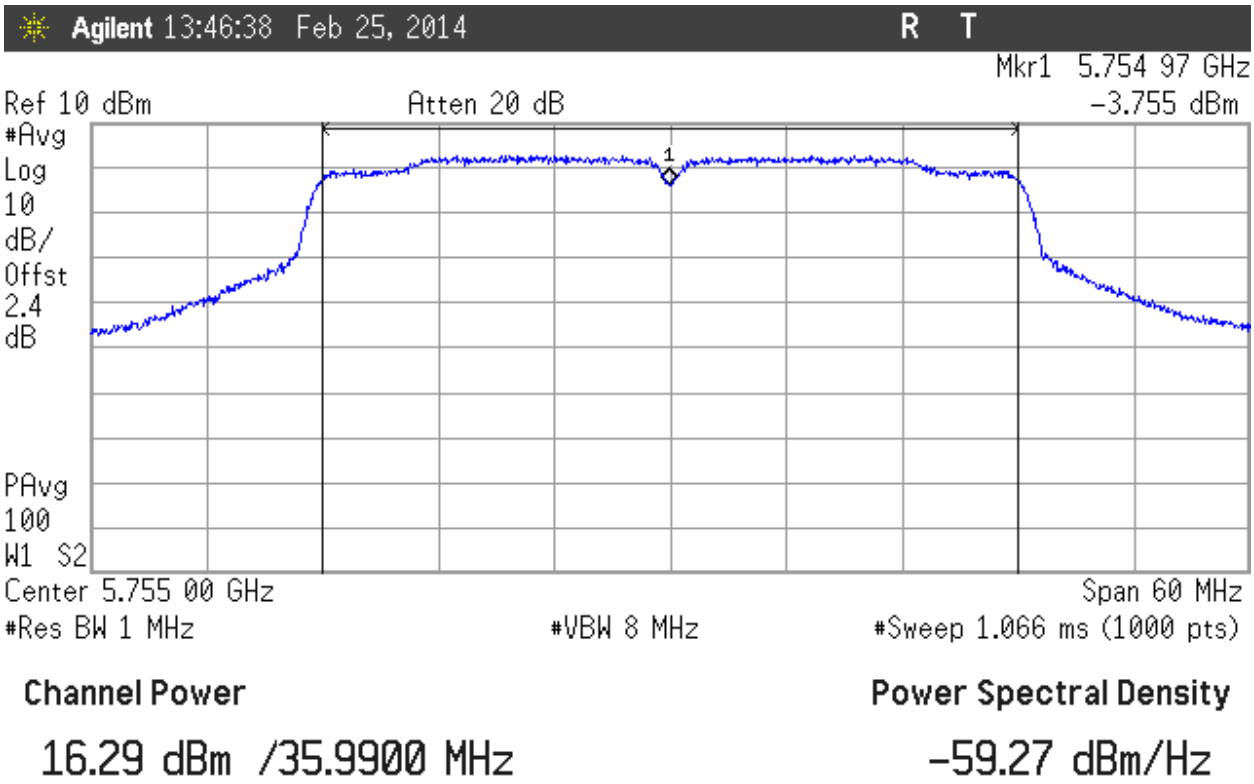


Highest Channel: 5825 MHz. Chain A+B. Port B

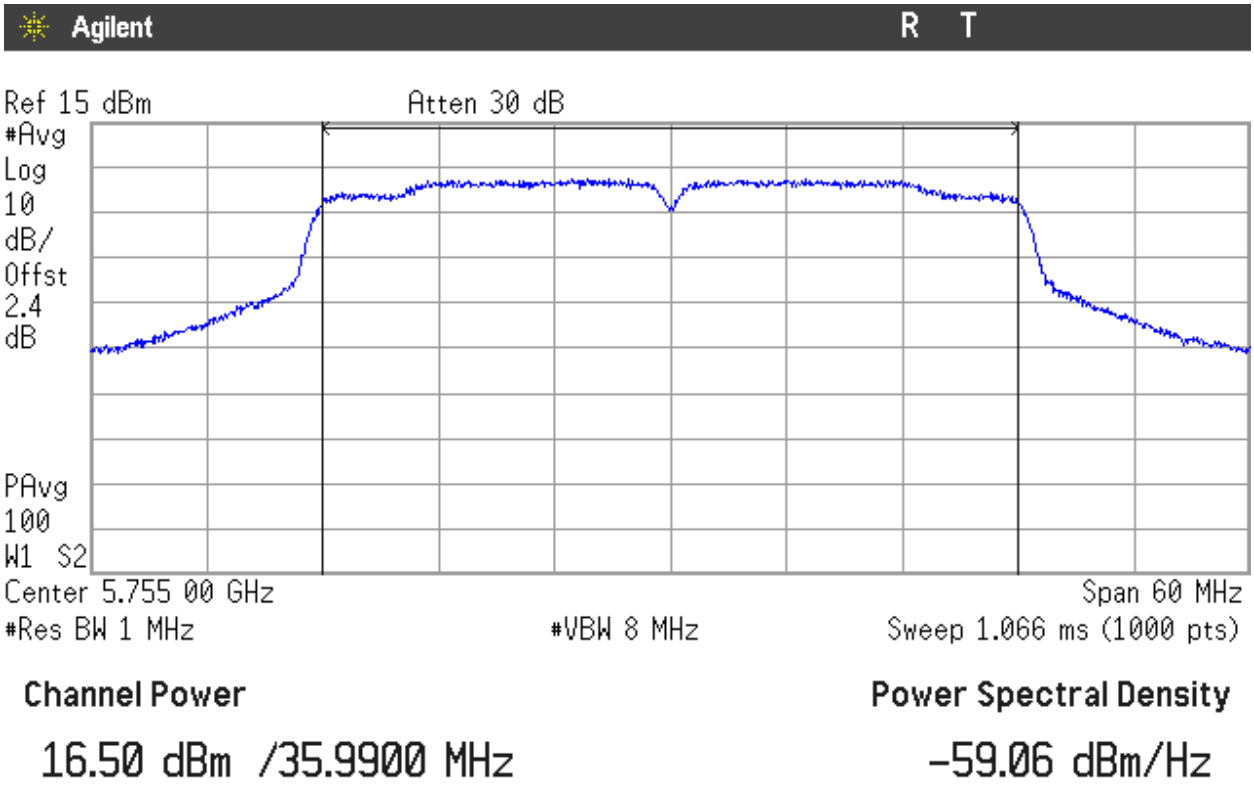


3. WiFi 5GHz 802.11 n40 mode

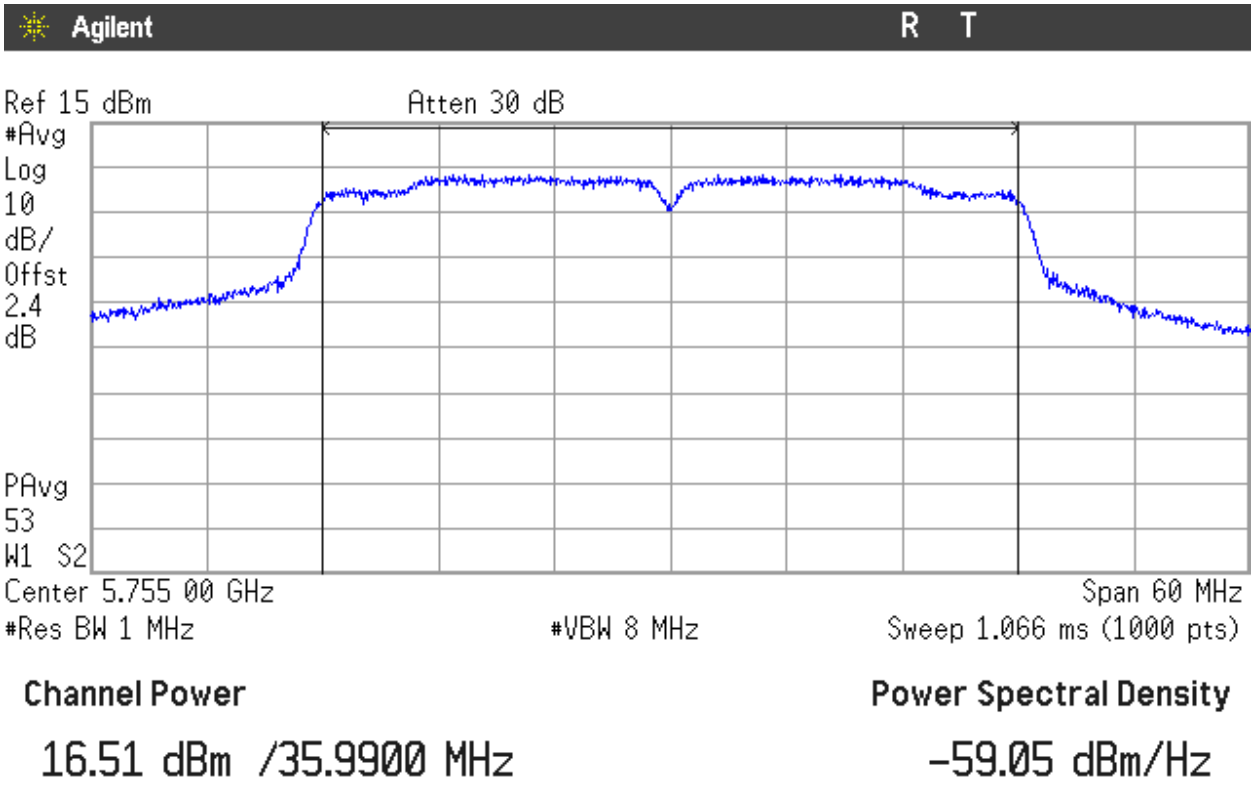
SISO. Lowest Channel: 5755 MHz. Chain A



MIMO. Lowest Channel: 5755 MHz. Chain A+B. Port A

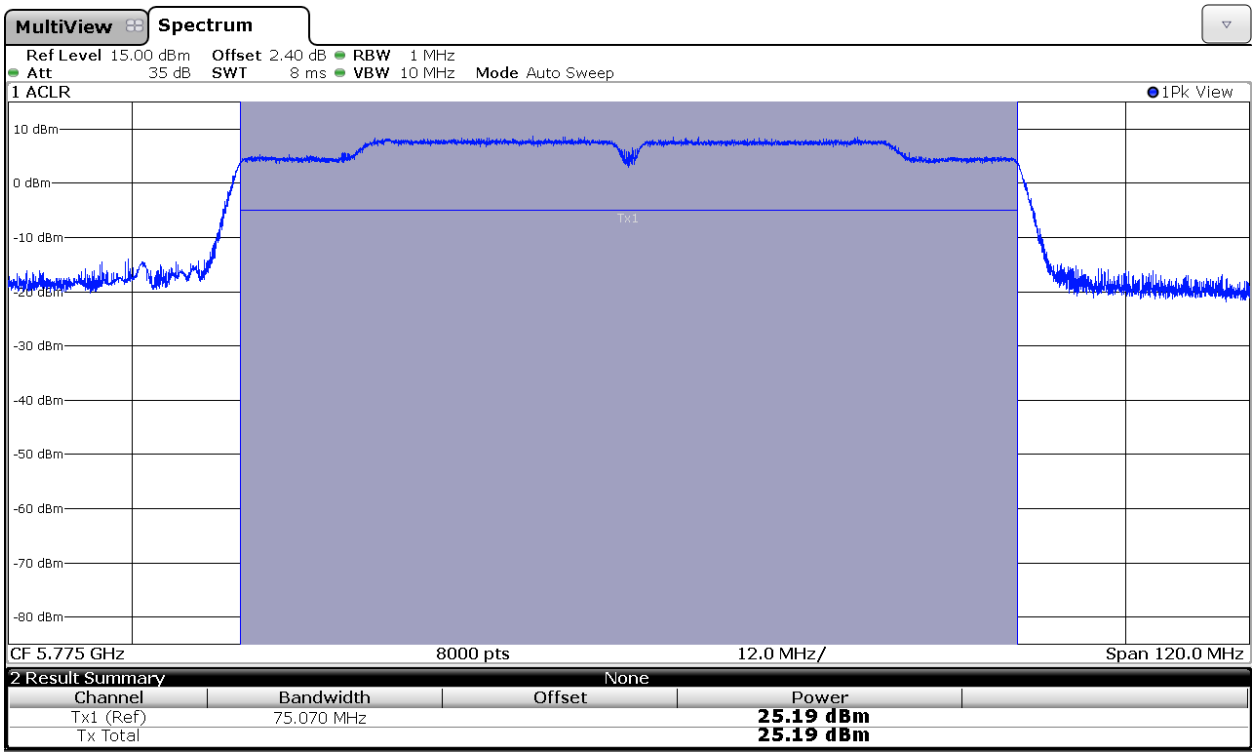


Lowest Channel: 5755 MHz. Chain A+B. Port B

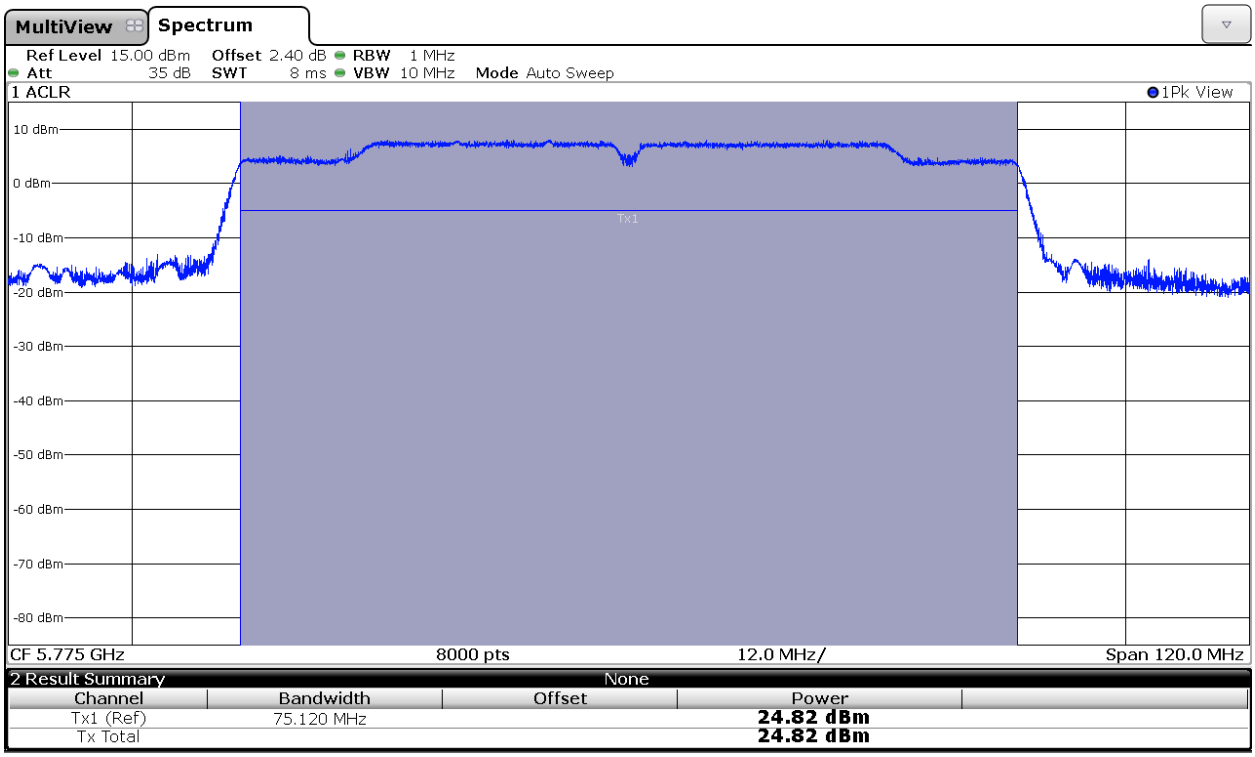


4. WiFi 5GHz 802.11 ac80 mode

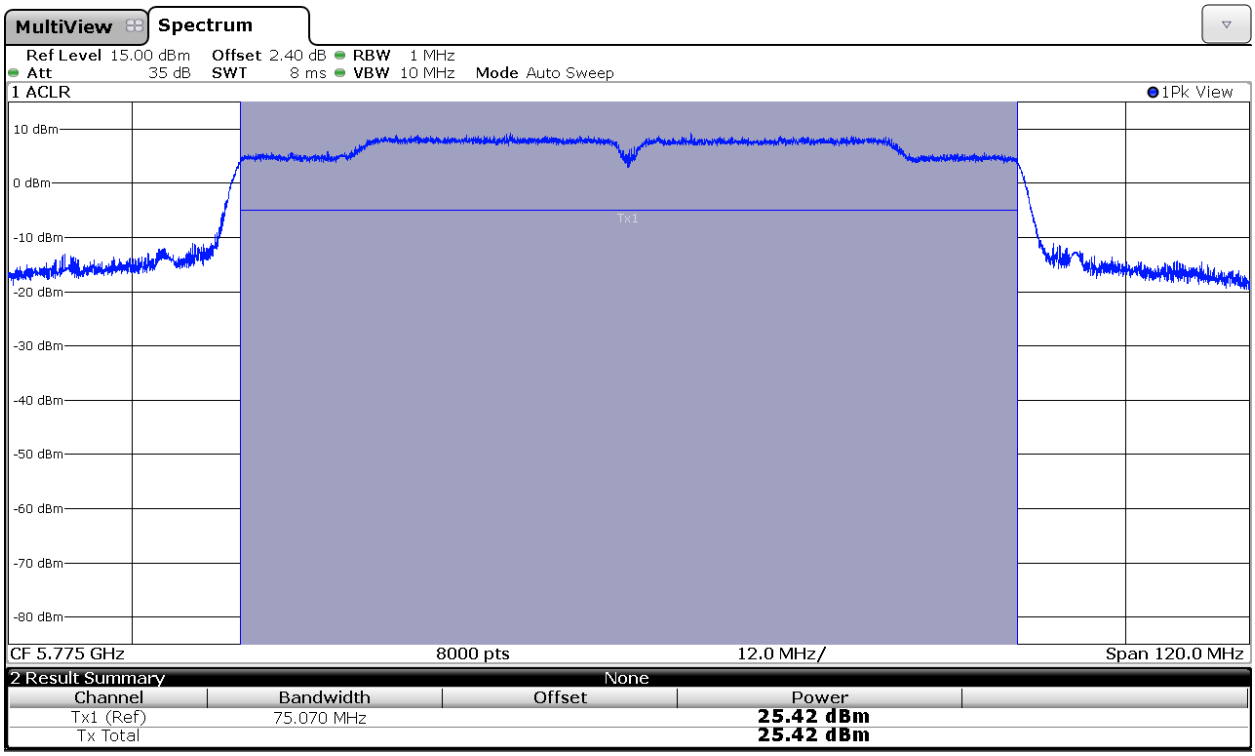
Peak Conducted Output Power.
SISO. Middle Channel: 5775 MHz. Chain B.



MIMO. Middle Channel: 5775 MHz. Chain A+B. Port A

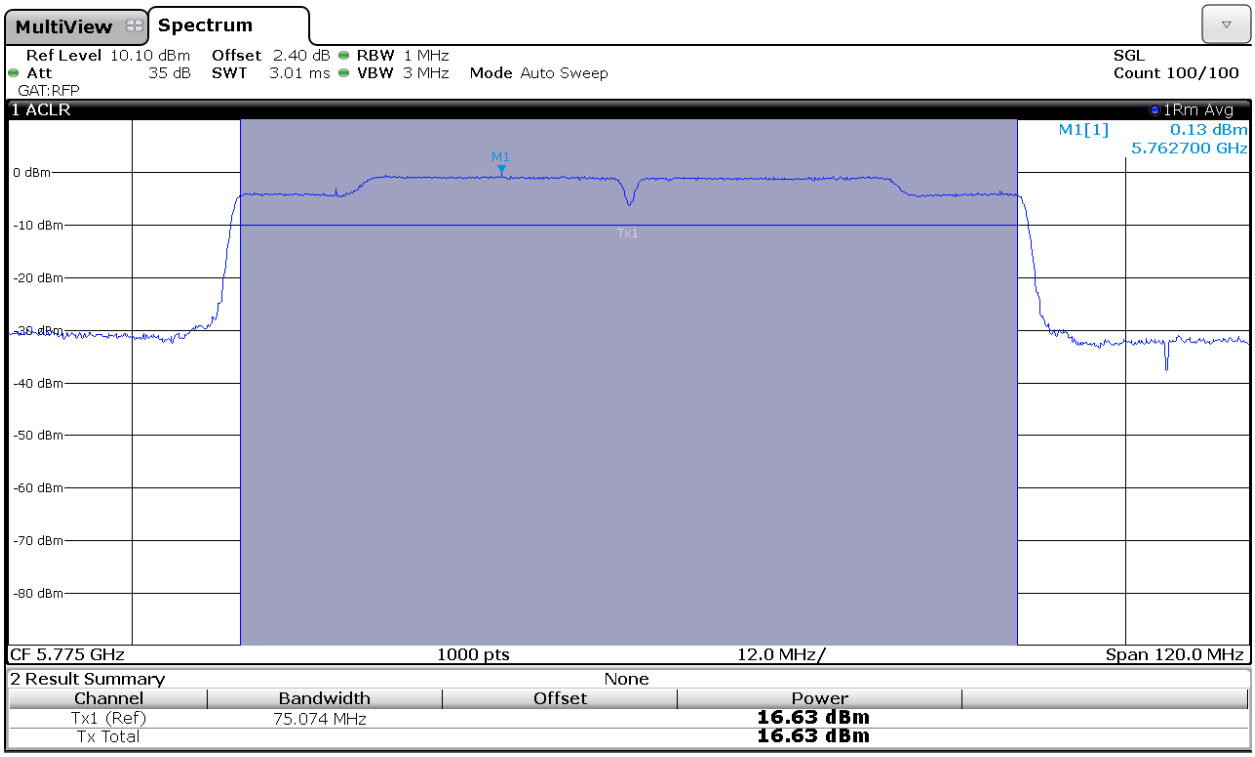


MIMO. Middle Channel: 5775 MHz. Chain A+B. Port B

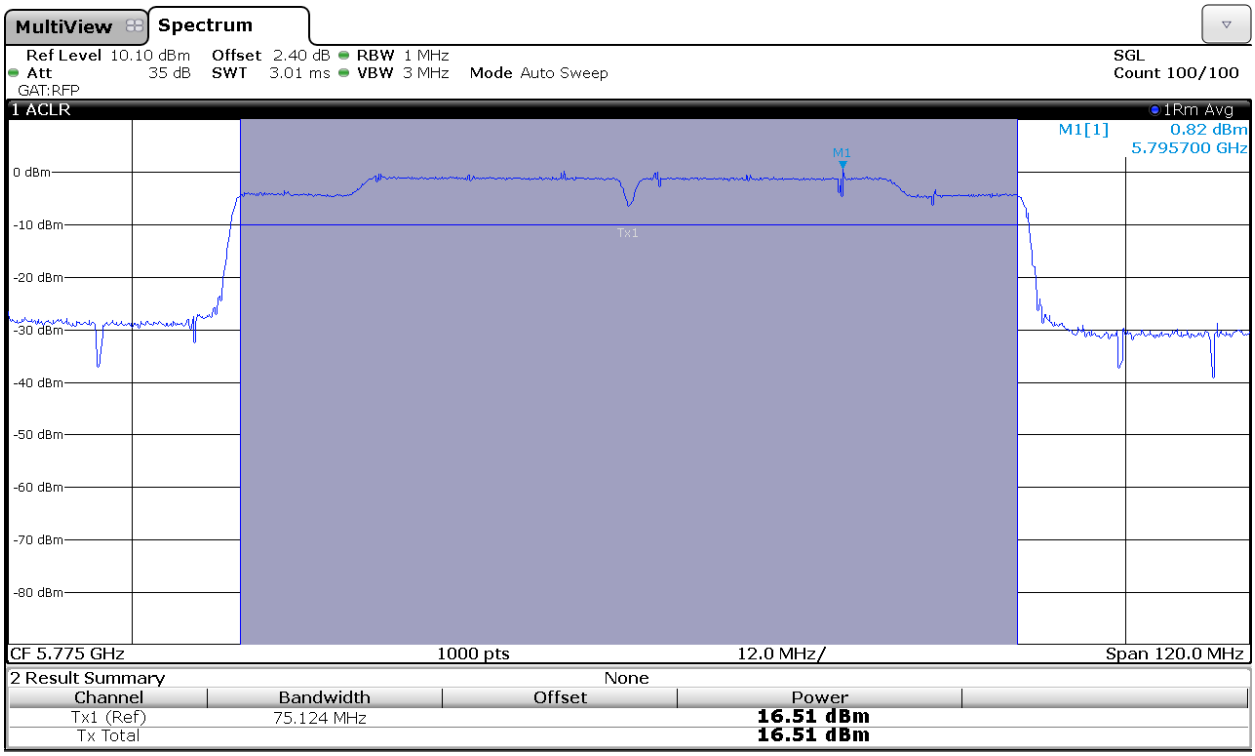


Conducted (average) output power (for information purposes only).

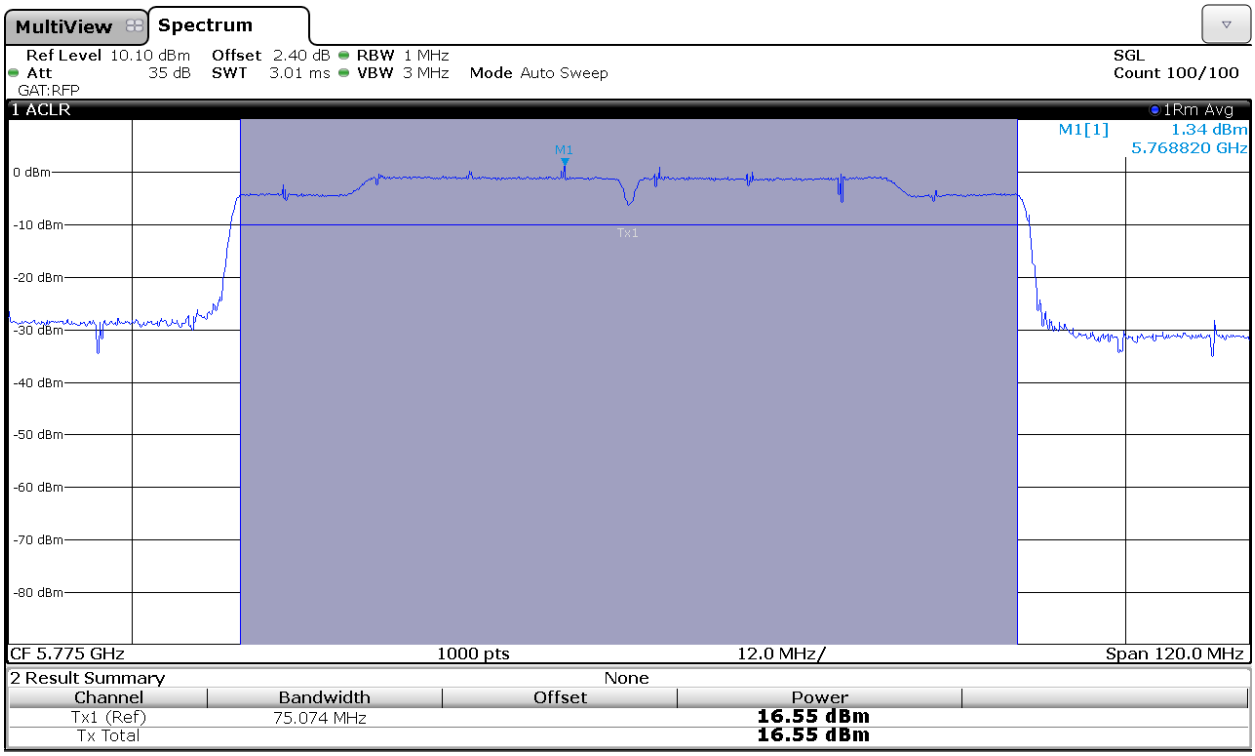
SISO. Middle Channel: 5775 MHz. Chain B.



MIMO. Middle Channel: 5775 MHz. Chain A+B. Port A



MIMO. Middle Channel: 5775 MHz. Chain A+B. Port B



Section 15.247 Subclause (d) / RSS-210 A8.5. Emission limitations conducted (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

1. WiFi 5GHz 802.11 a mode

Reference Level Measurement

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
Reference Level Measurement (dBm)	5.90	4.09	5.87	4.13	5.87	4.44
Measurement uncertainty (dB)	±1.5					

Chain A / Chain B

Lowest frequency 5745 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.10 / -25.91

Middle frequency 5785 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.13 / -25.87

Highest frequency 5825 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.13 / -25.56

Verdict: PASS

2. WiFi 5GHz 802.11 n20 mode

Reference Level Measurement

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
Reference Level Measurement (dBm)	5.18	3.57	5.66	3.79	5.38	4.41
Measurement uncertainty (dB)	±1.5					

Chain A / Chain B

Lowest frequency 5745 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.82 / -26.43

Middle frequency 5785 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.34 / -26.21

Highest frequency 5825 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-24.62 / -25.59

Verdict: PASS

3. WiFi 5GHz 802.11 n40 mode

Reference Level Measurement

	Lowest frequency 5755 MHz		Highest frequency 5795 MHz	
	Chain A	Chain B	Chain A	Chain B
Reference Level Measurement (dBm)	2.87	2.07	3.83	2.67
Measurement uncertainty (dB)	±1.5			

Chain A

Lowest frequency 5755 MHz

Spurious frequency (GHz)	Level (dBm)	Limit (dBm)
17.27235	-45.46	-27.13

Highest frequency 5795 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-26.17

Chain B

Lowest frequency 5755 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-27.93

Highest frequency 5795 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-27.33

Verdict: PASS

4. WiFi 5GHz 802.11 ac80 mode

Reference Level Measurement

	Middle frequency 5775 MHz	
	Chain A	Chain B
Reference Level Measurement (dBm)	1.12	0.45
Measurement uncertainty (dB)	±1.5	

Chain A / Chain B

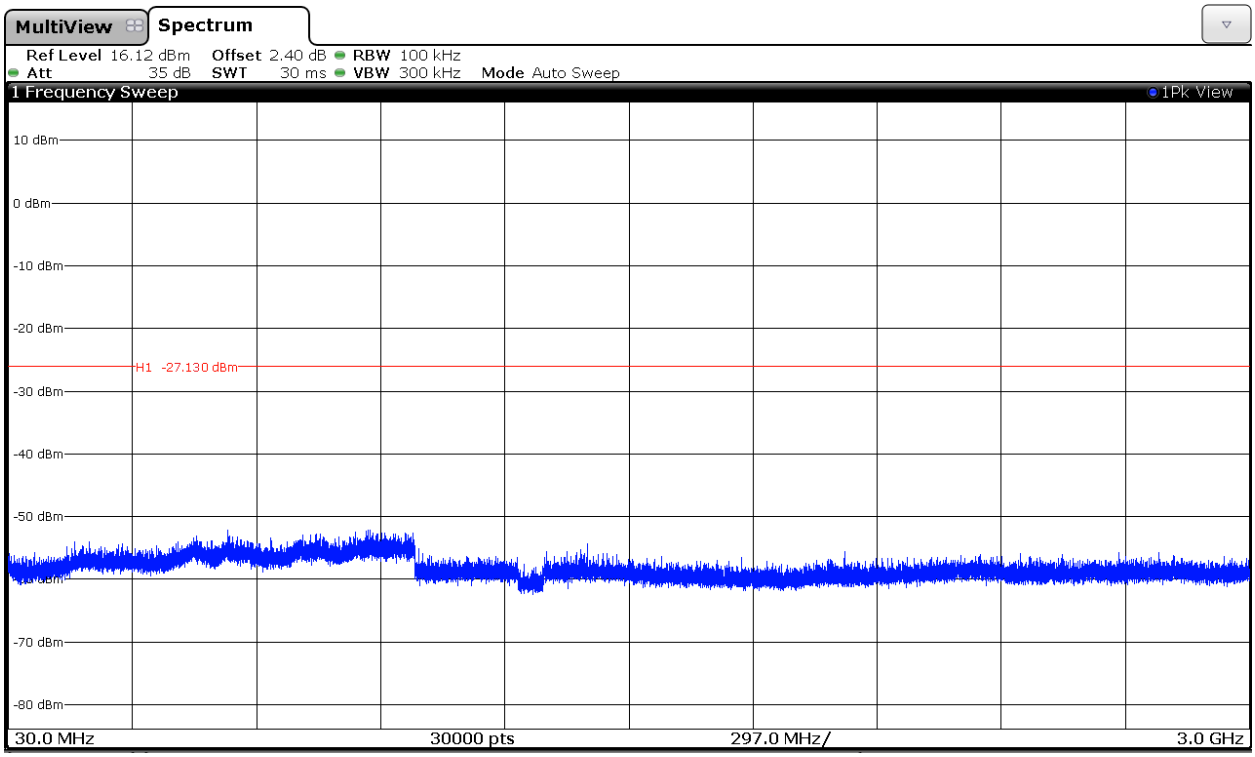
Middle frequency 5775 MHz	Limit (dBm)
All peaks are more than 20 dB below the limit.	-18.88 / -19.55

Verdict: PASS (NOTE: The limit is set to -20 dBc since the maximum peak conducted output power was measured for this mode.)

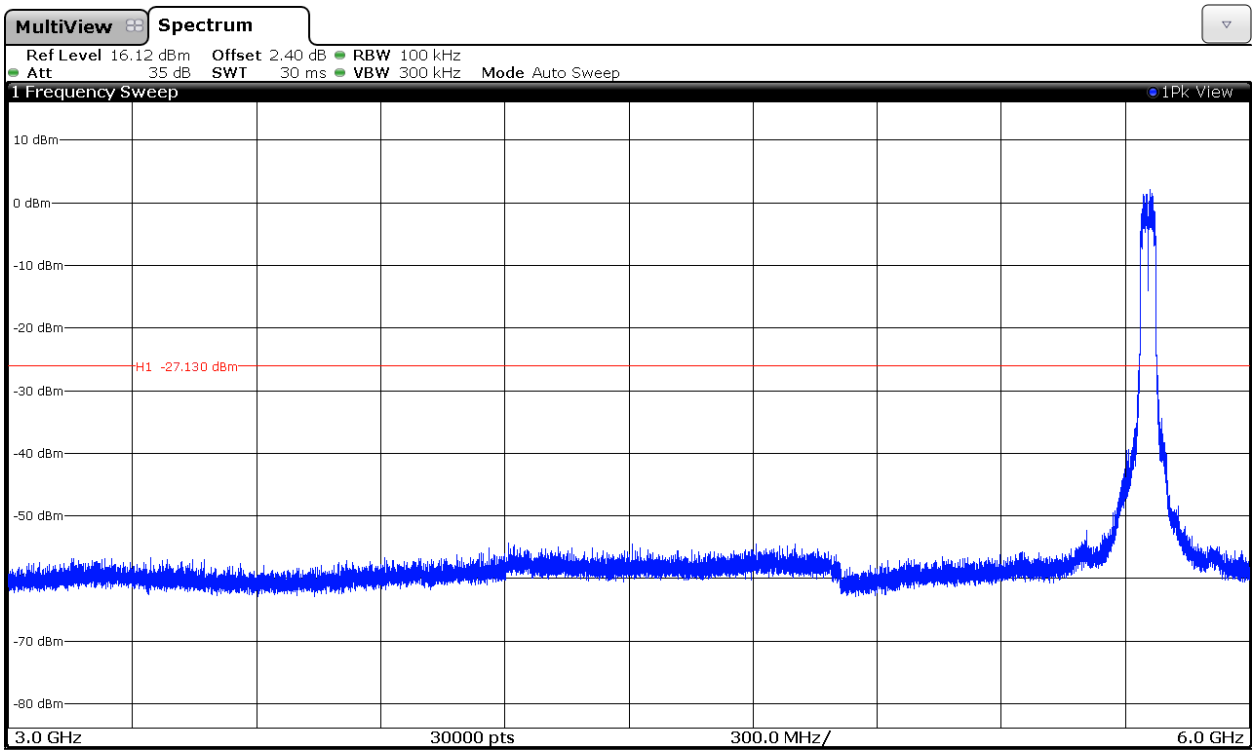
See next plot of worst case: Mode n40. Lowest Channel. Chain A: 5755 MHz.

Number of sweep points: 30,000.

Plot 30 MHz to 3 GHz:

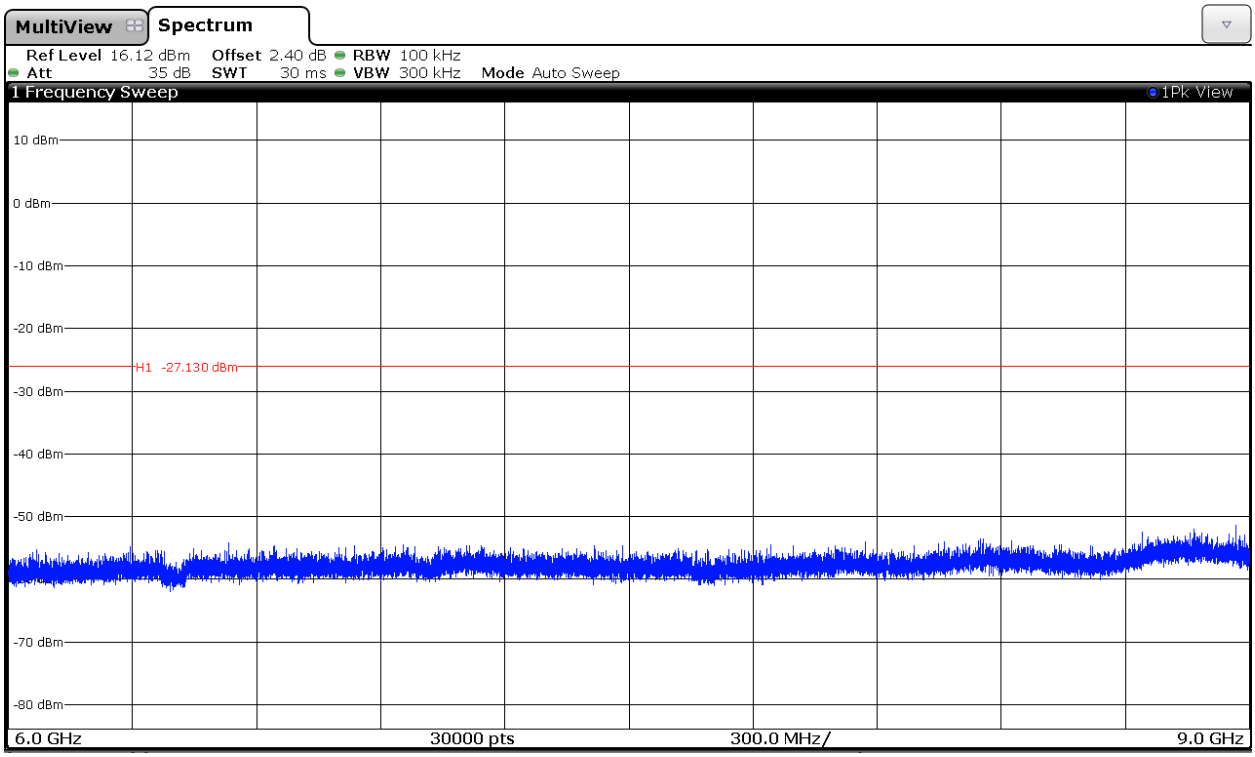


Plot 3 GHz to 6 GHz:

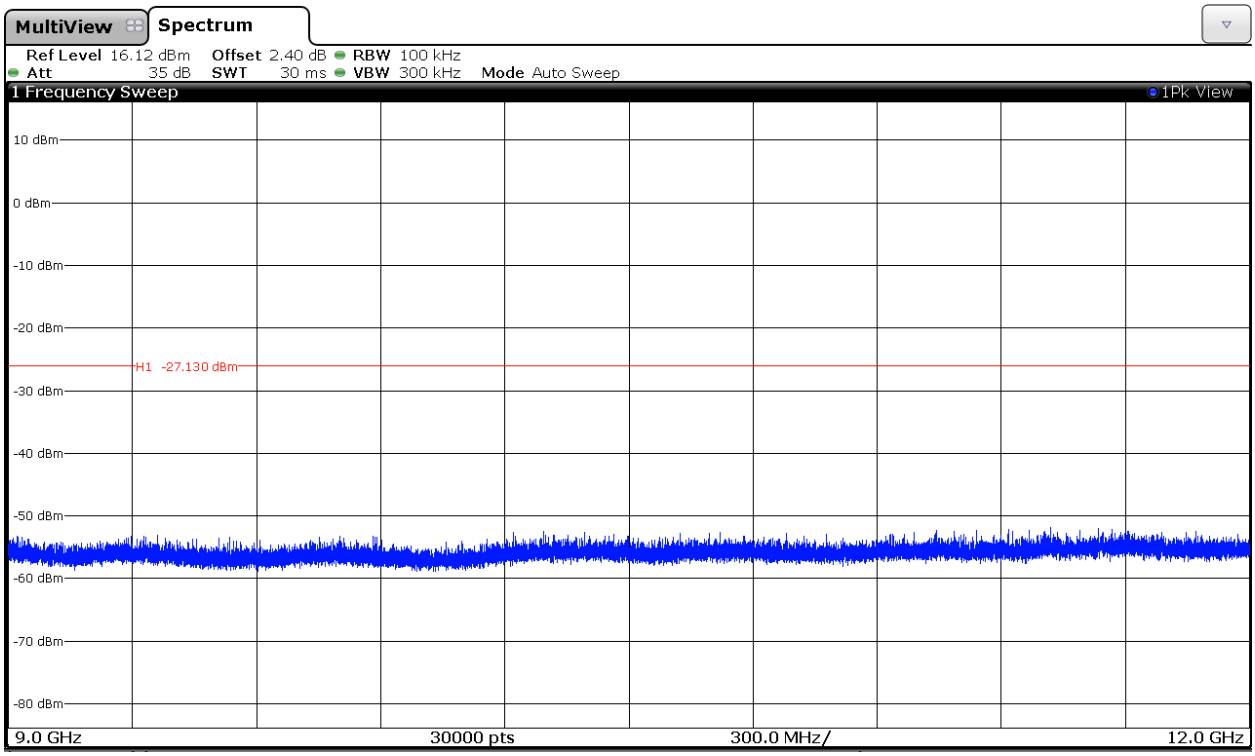


Note: The peak above the limit is the carrier frequency.

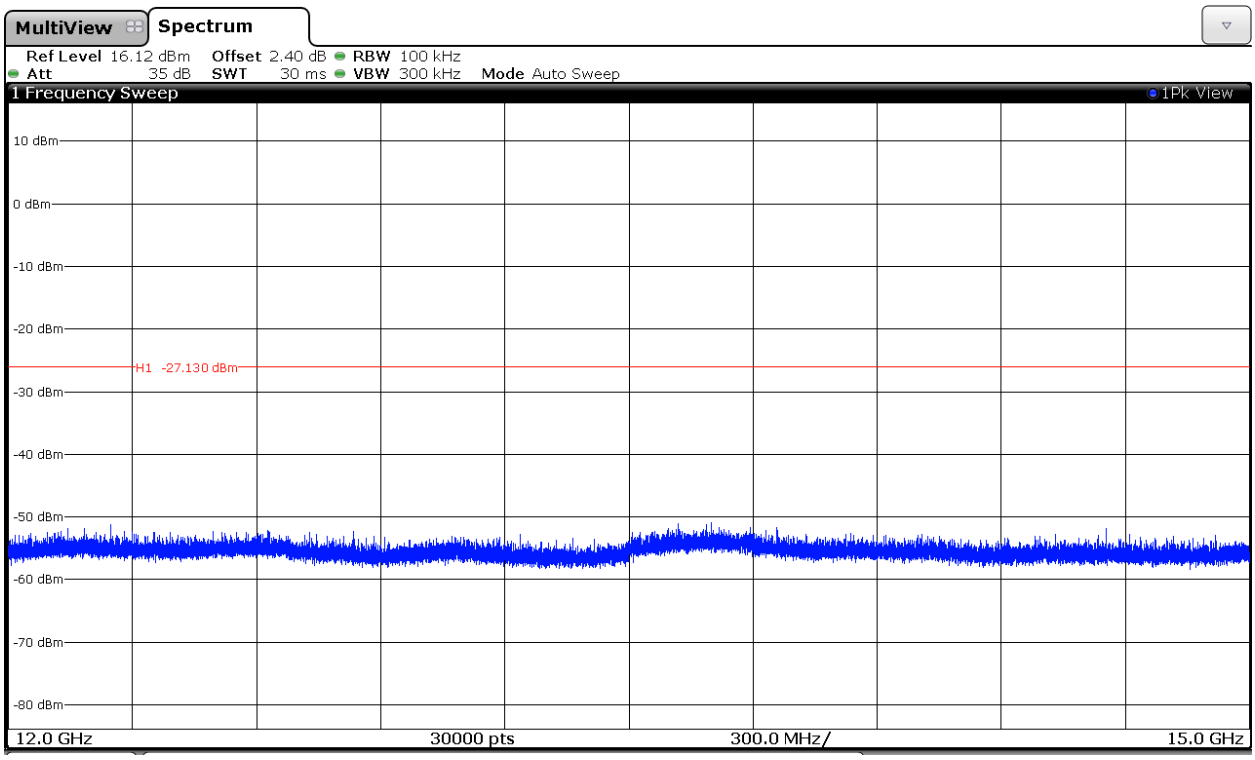
Plot 6 GHz to 9 GHz:



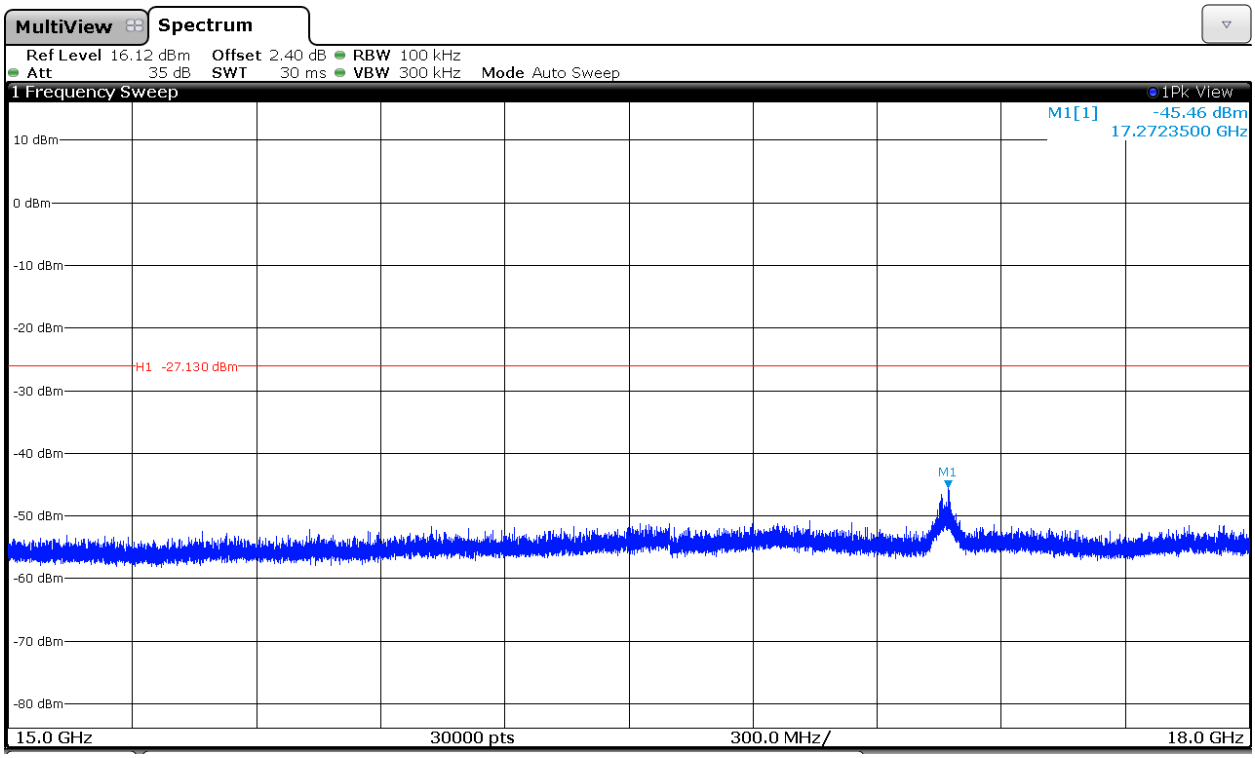
Plot 9 GHz to 12 GHz:



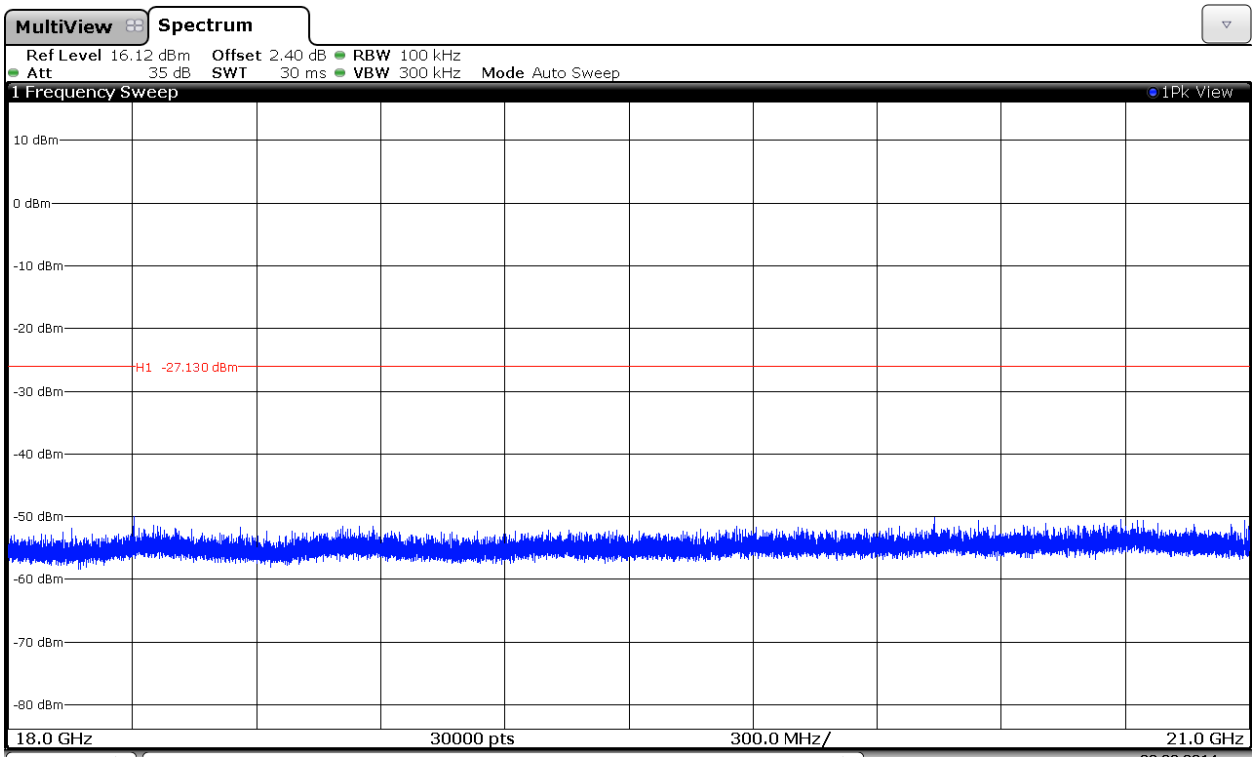
Plot 12 GHz to 15 GHz:



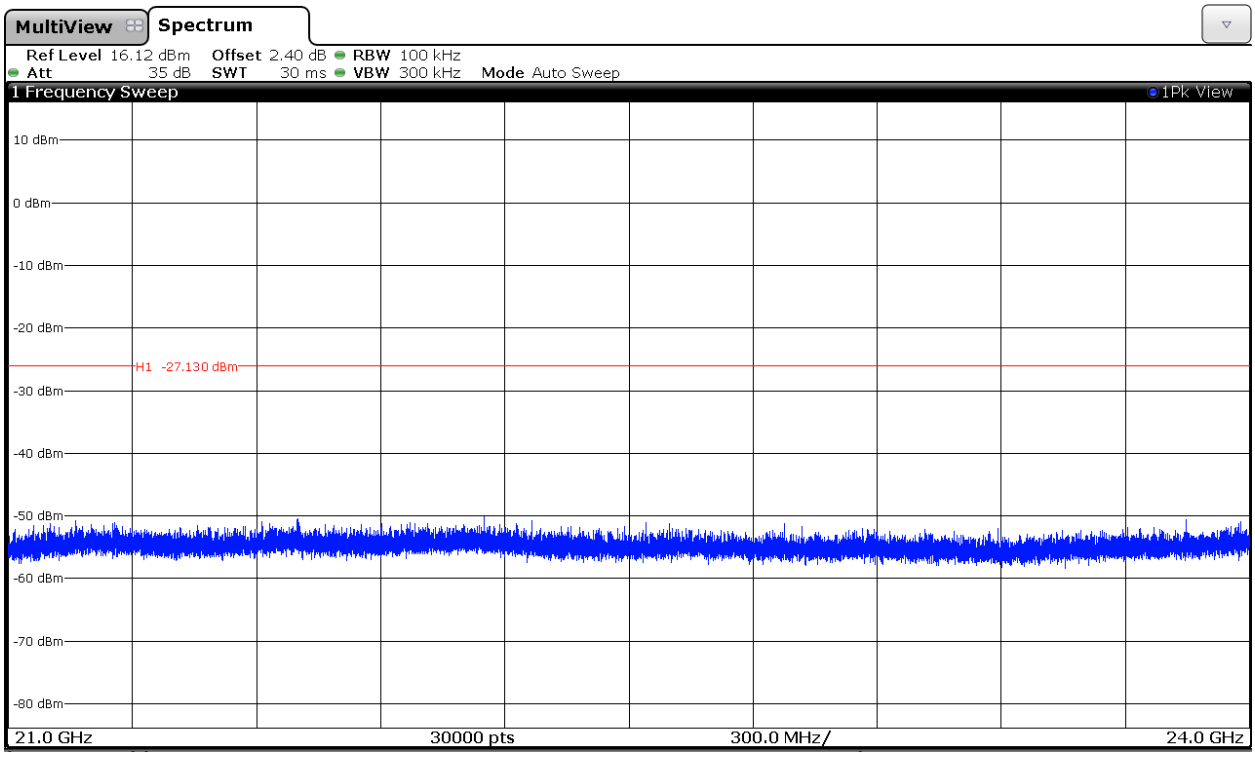
Plot 15 GHz to 18 GHz:



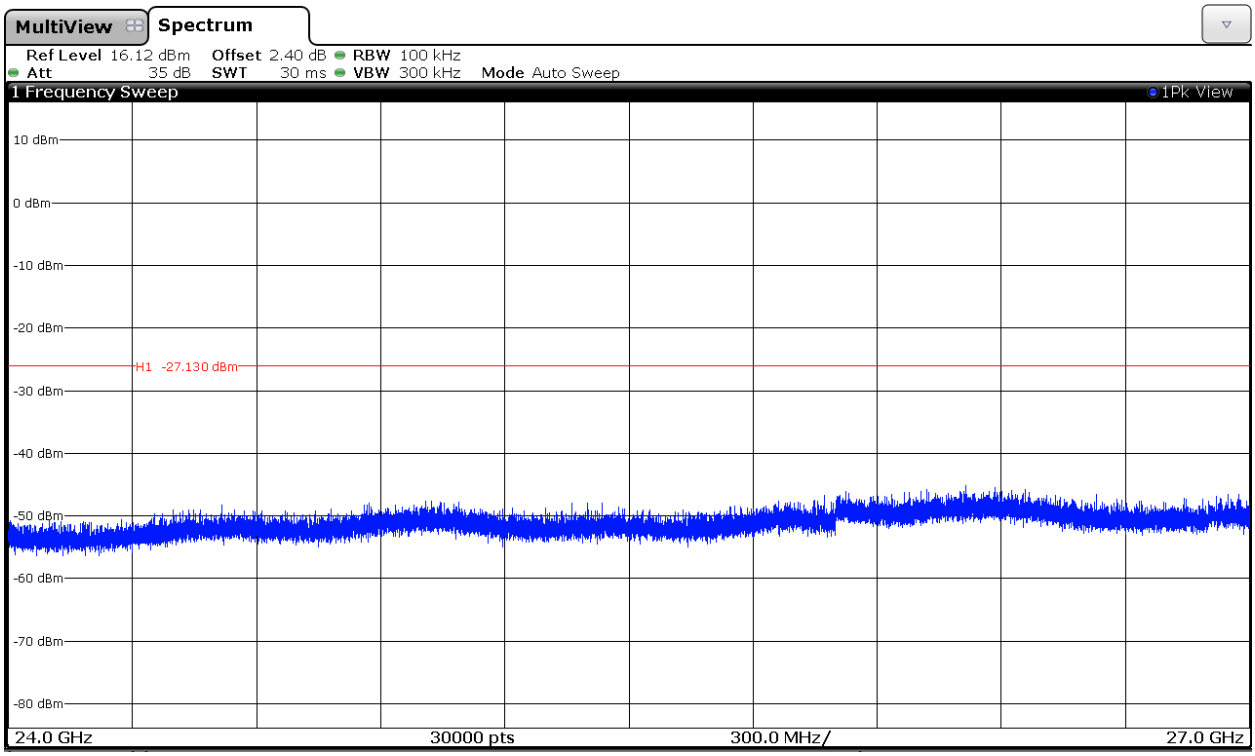
Plot 18 GHz to 21 GHz:



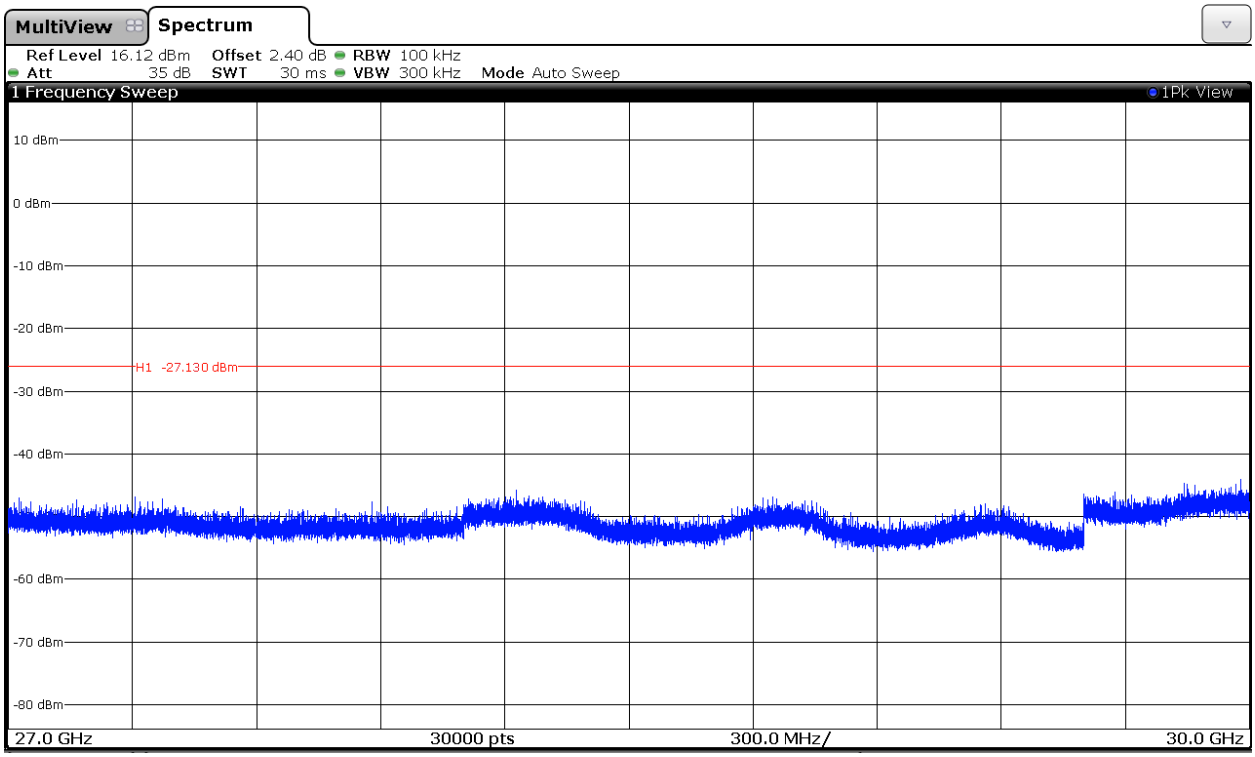
Plot 21 GHz to 24 GHz:



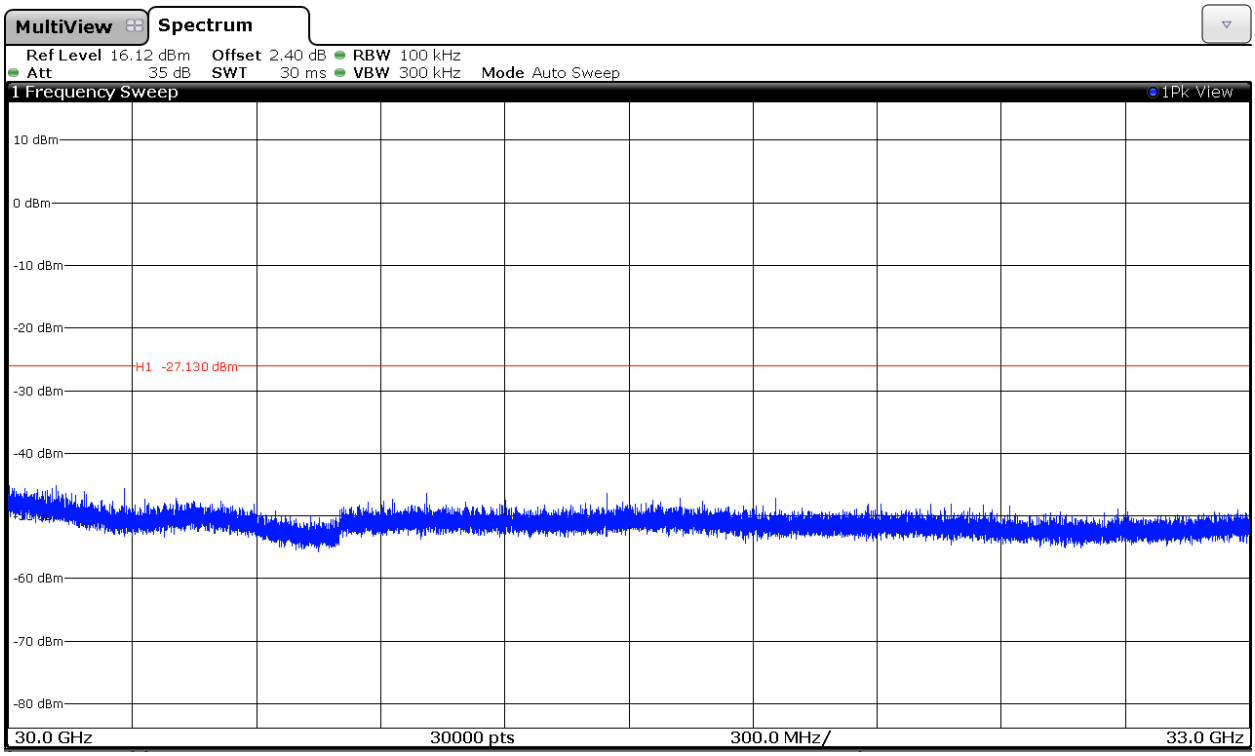
Plot 24 GHz to 27 GHz:



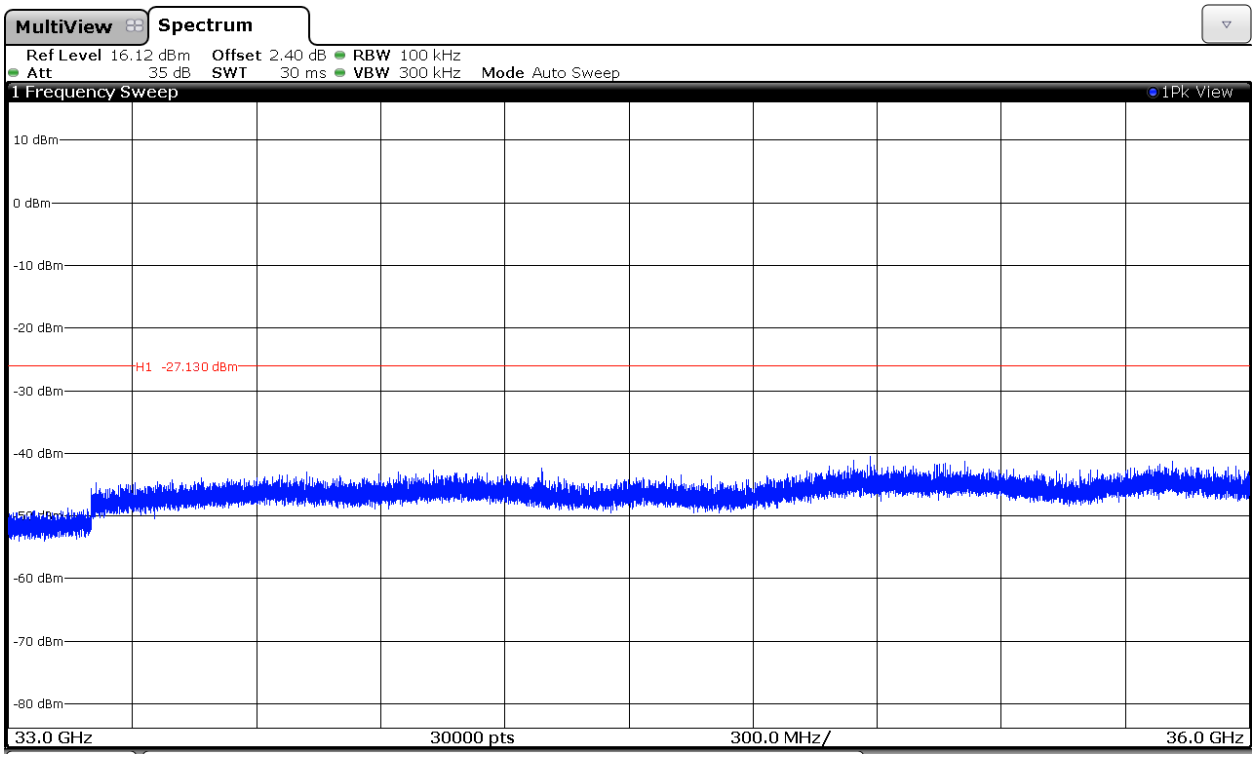
Plot 27 GHz to 30 GHz:



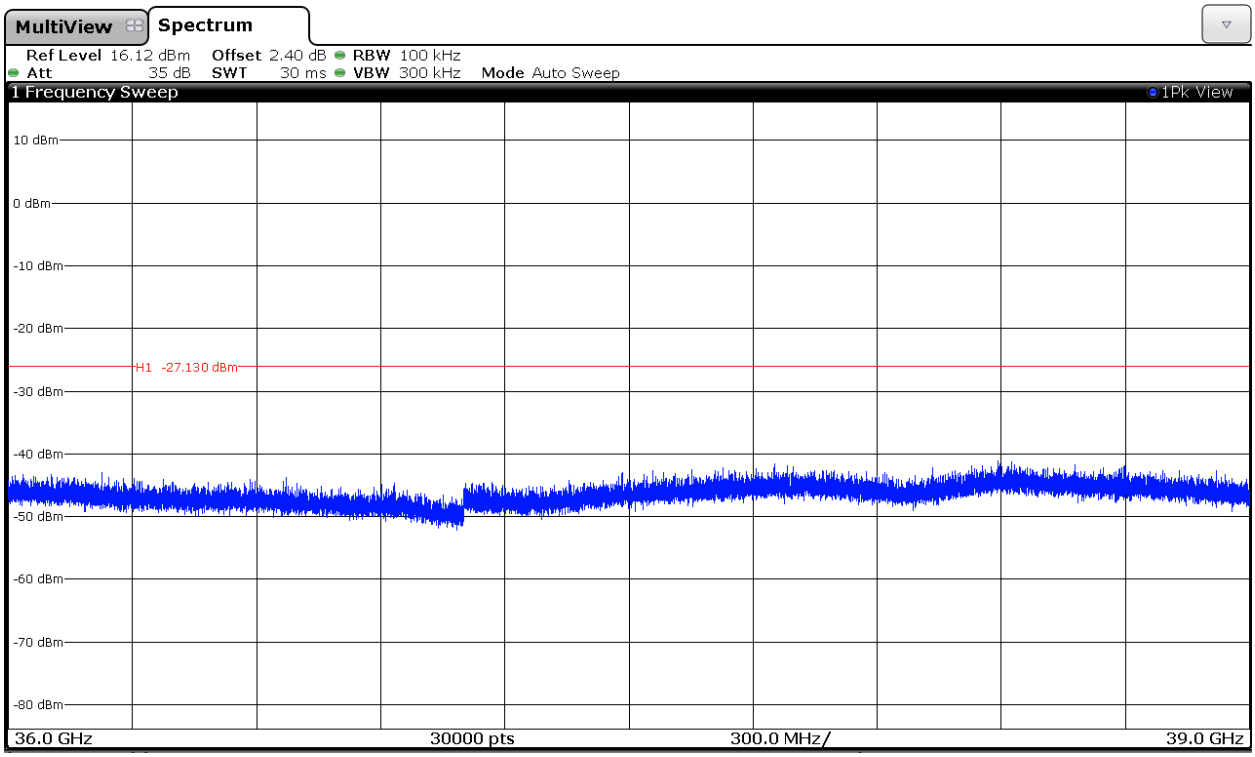
Plot 30 GHz to 33 GHz:



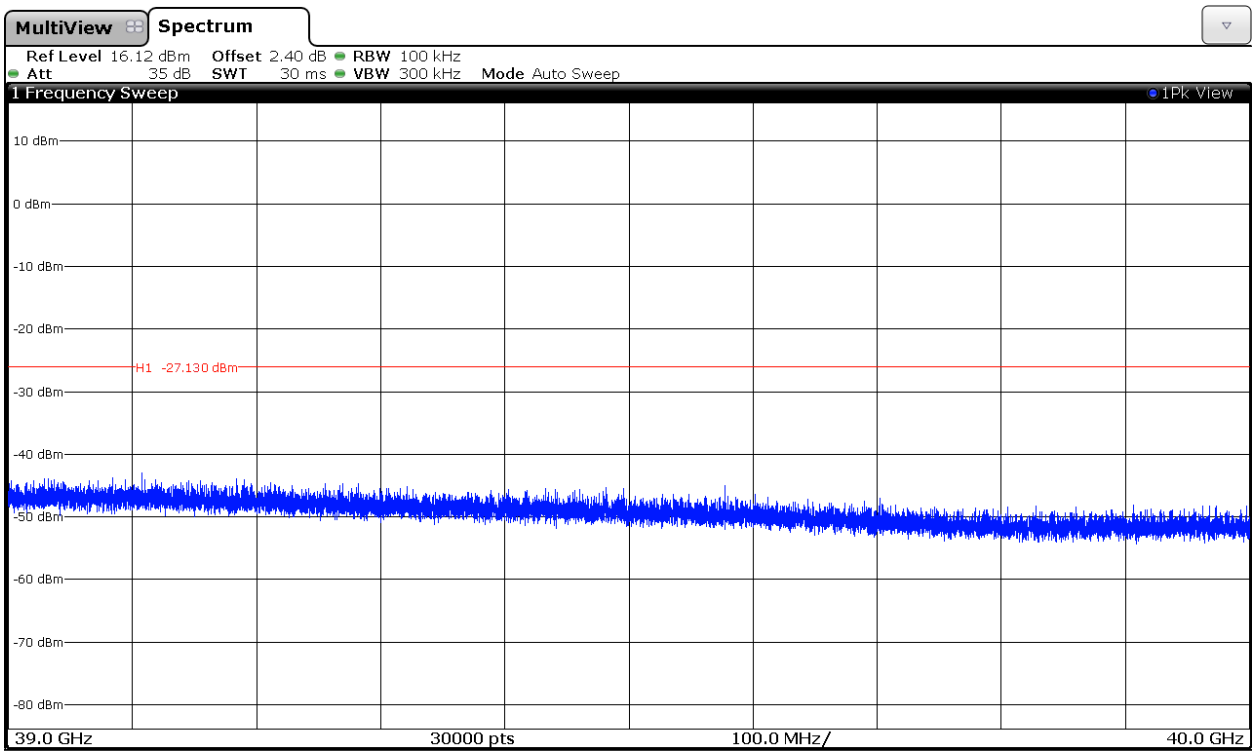
Plot 33 GHz to 36 GHz:



Plot 36 GHz to 39 GHz:



Plot 39 GHz to 40 GHz:



Section 15.247 Subclause (d) / RSS-210 A8.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION

Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

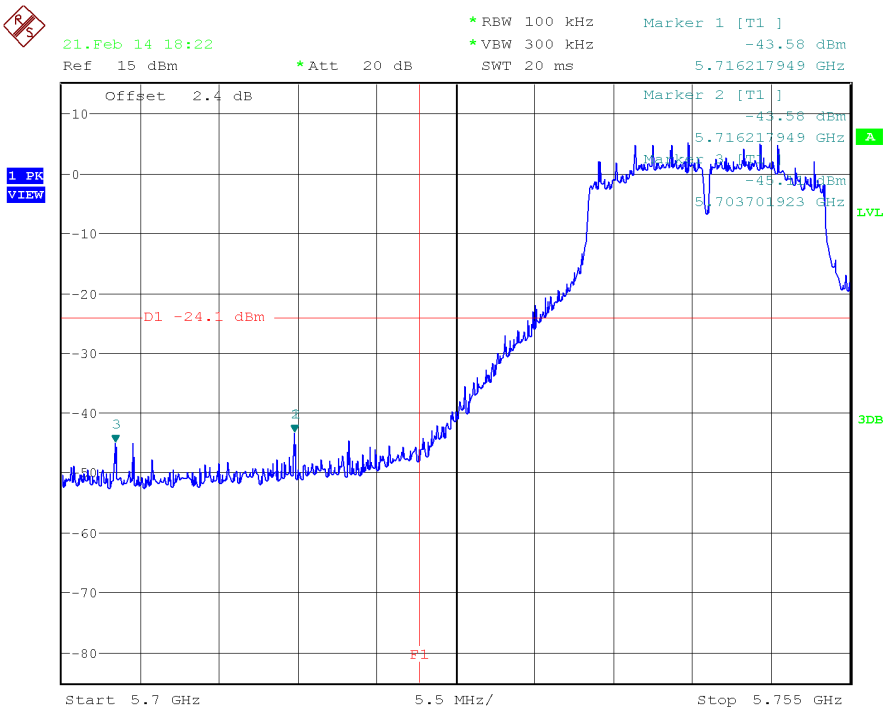
RESULTS:

1. WiFi 5GHz 802.11 a mode

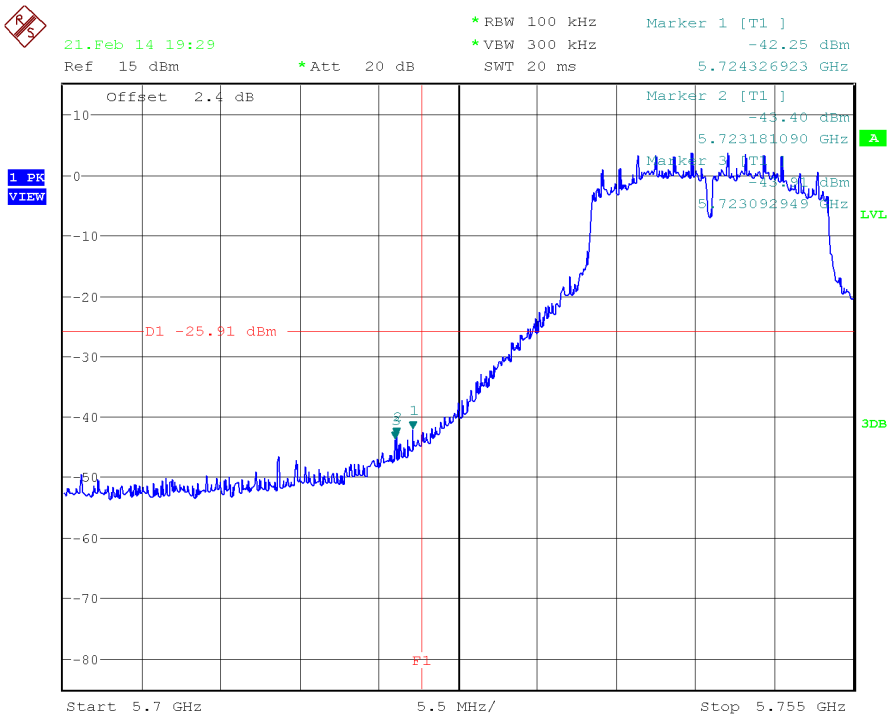
LOW FREQUENCY SECTION 5745 MHz. CONDUCTED.

See next plots.

Chain A



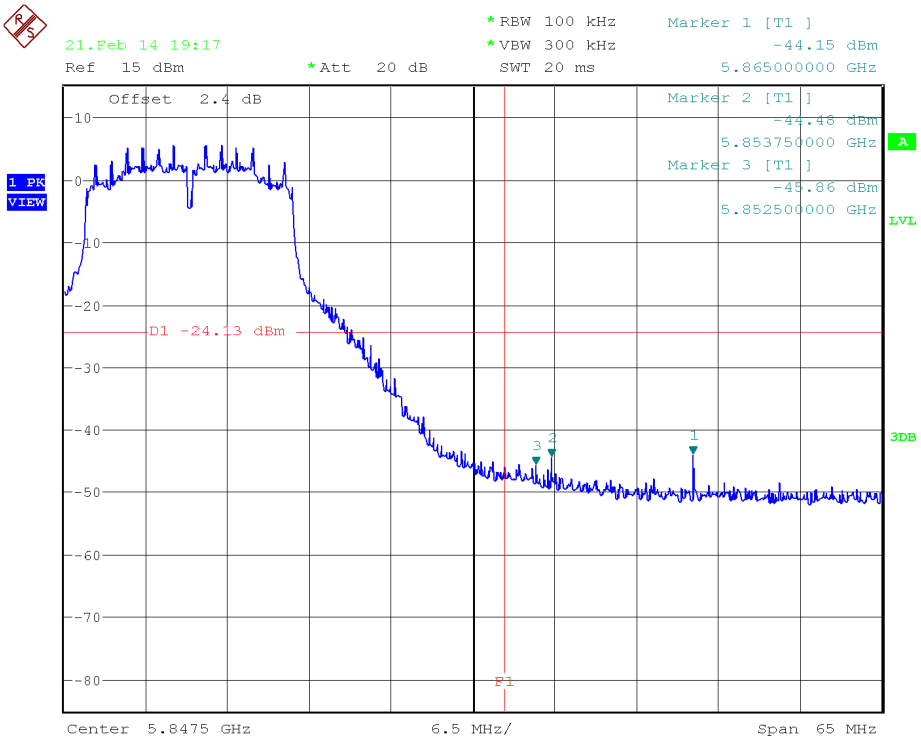
Chain B



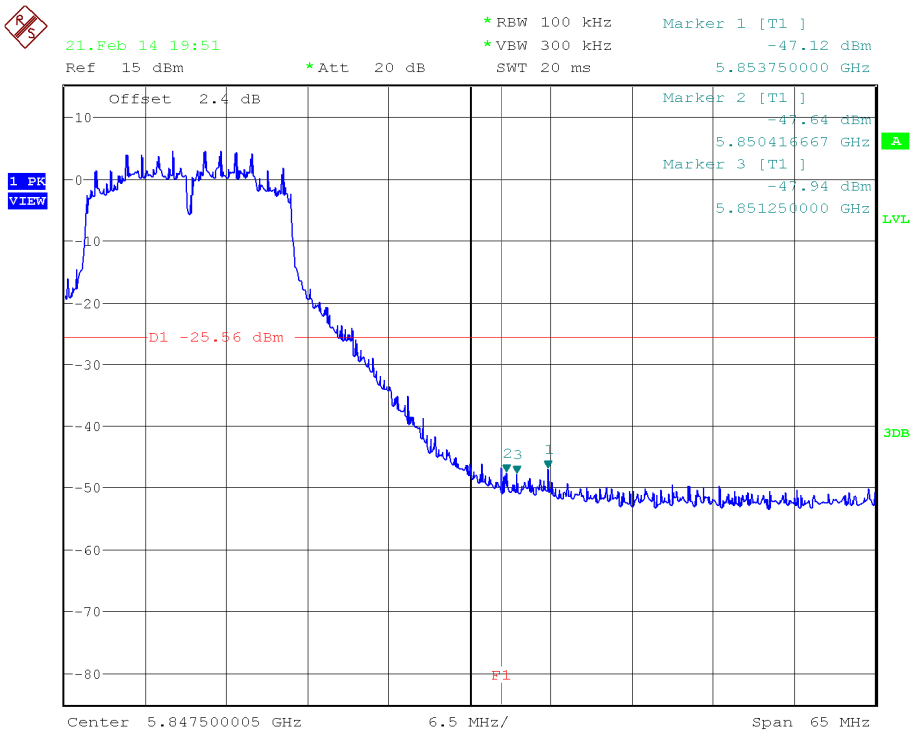
HIGH FREQUENCY SECTION 5825 MHz. CONDUCTED.

See next plots.

Chain A



Chain B



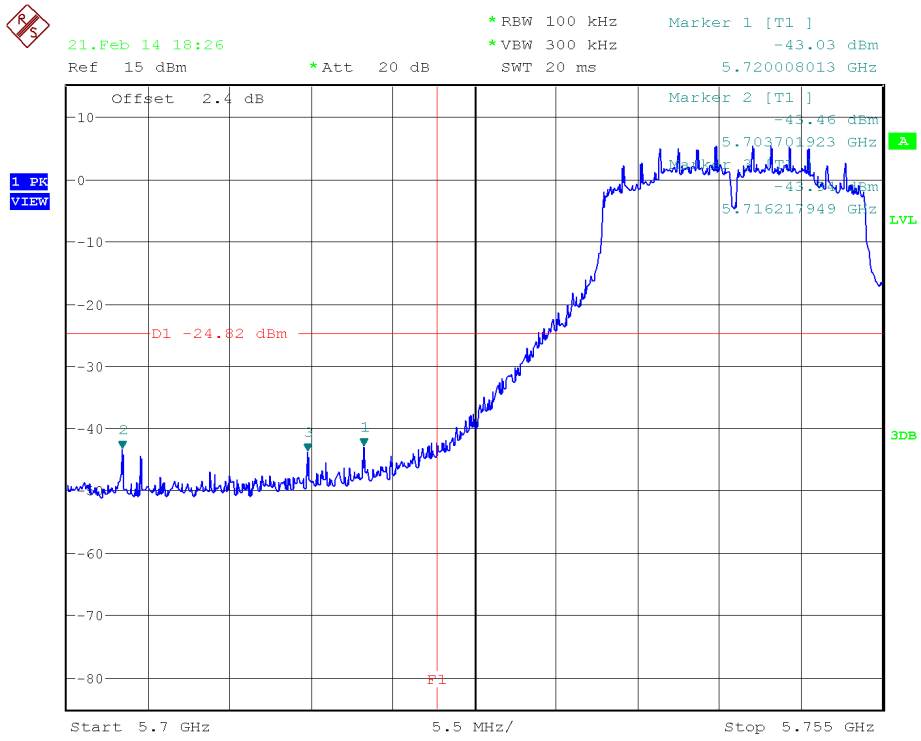
Verdict: PASS

2. WiFi 5GHz 802.11 n20 mode

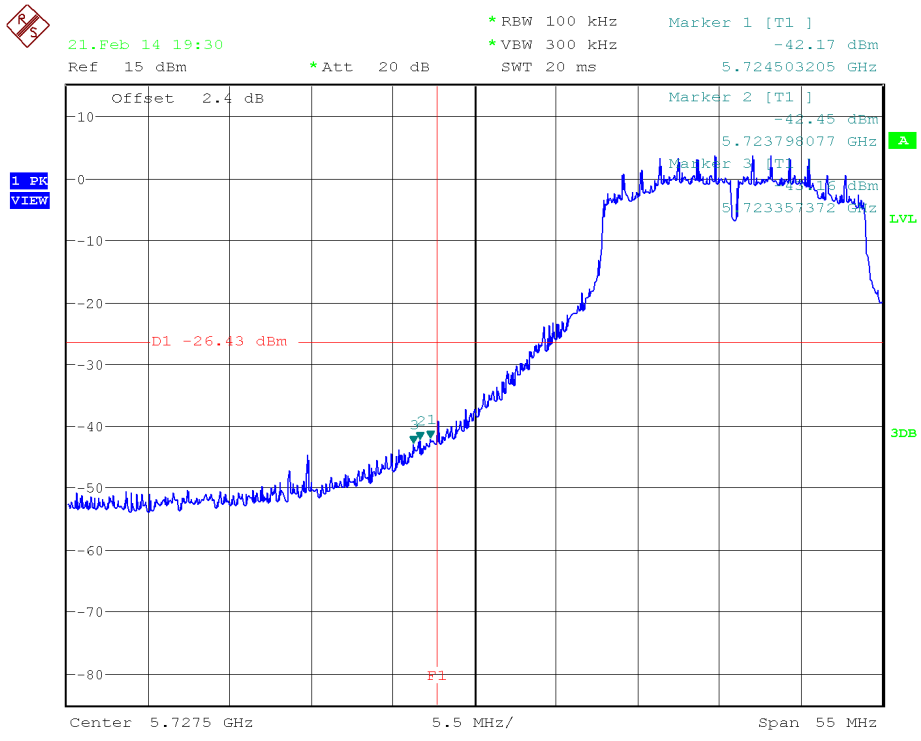
LOW FREQUENCY SECTION 5745 MHz. CONDUCTED.

See next plots.

Chain A



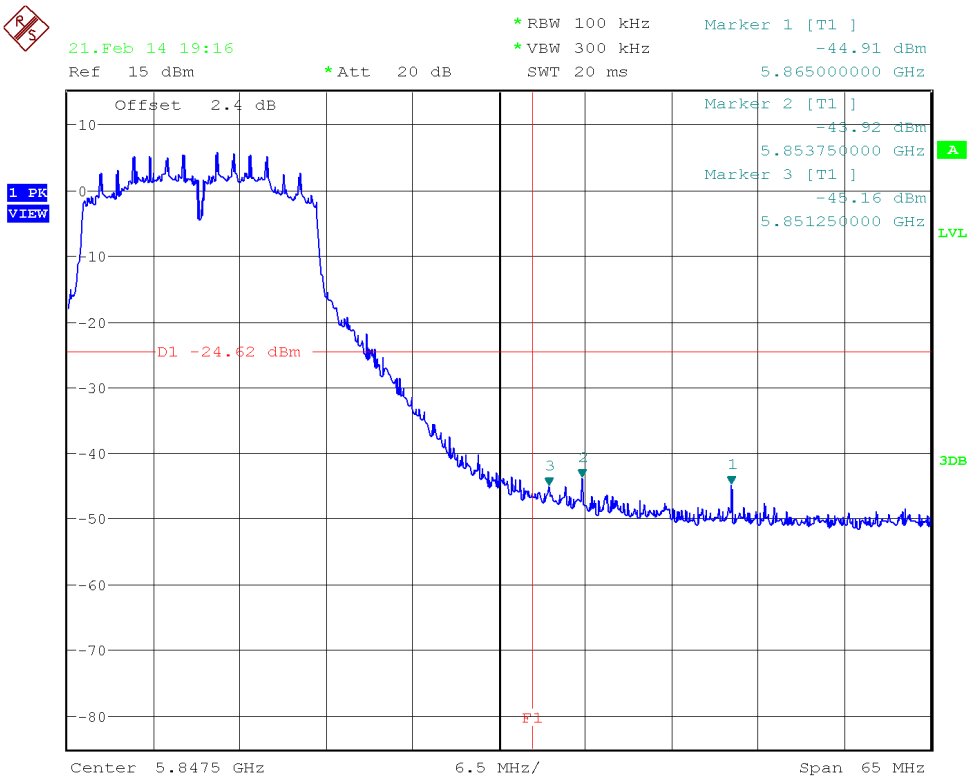
Chain B



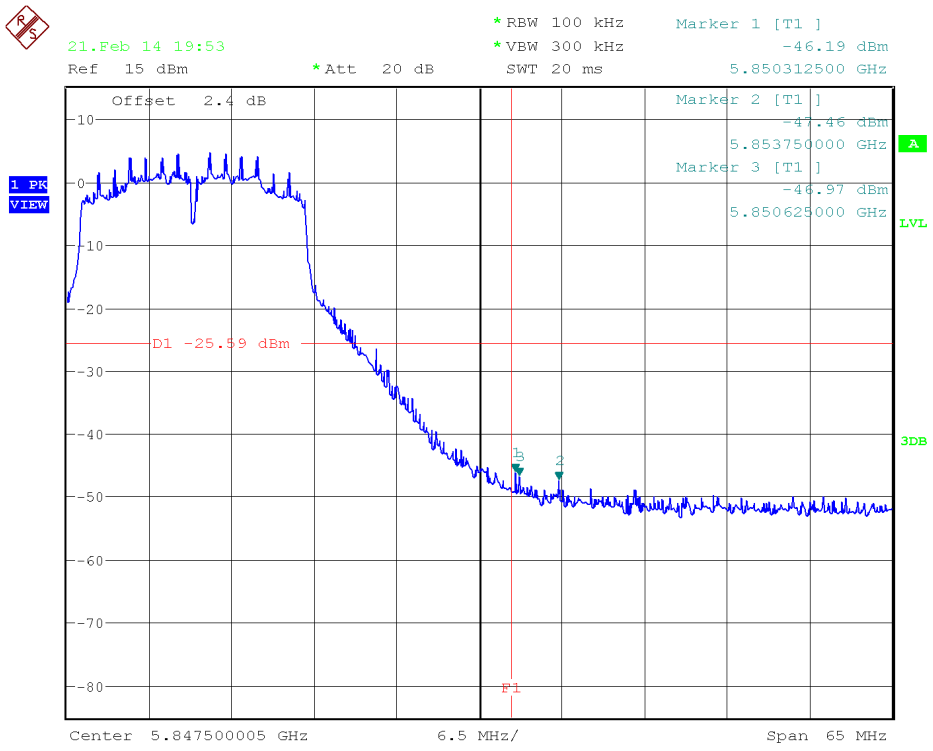
HIGH FREQUENCY SECTION 5825 MHz. CONDUCTED.

See next plots.

Chain A



Chain B



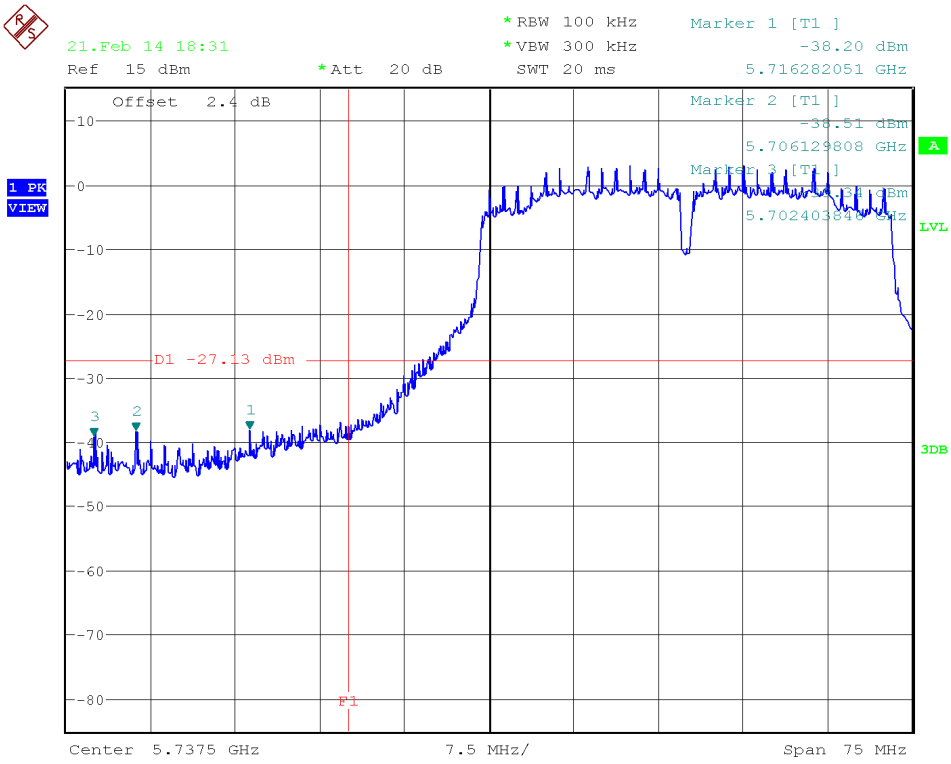
Verdict: PASS

3. WiFi 5GHz 802.11 n40 mode

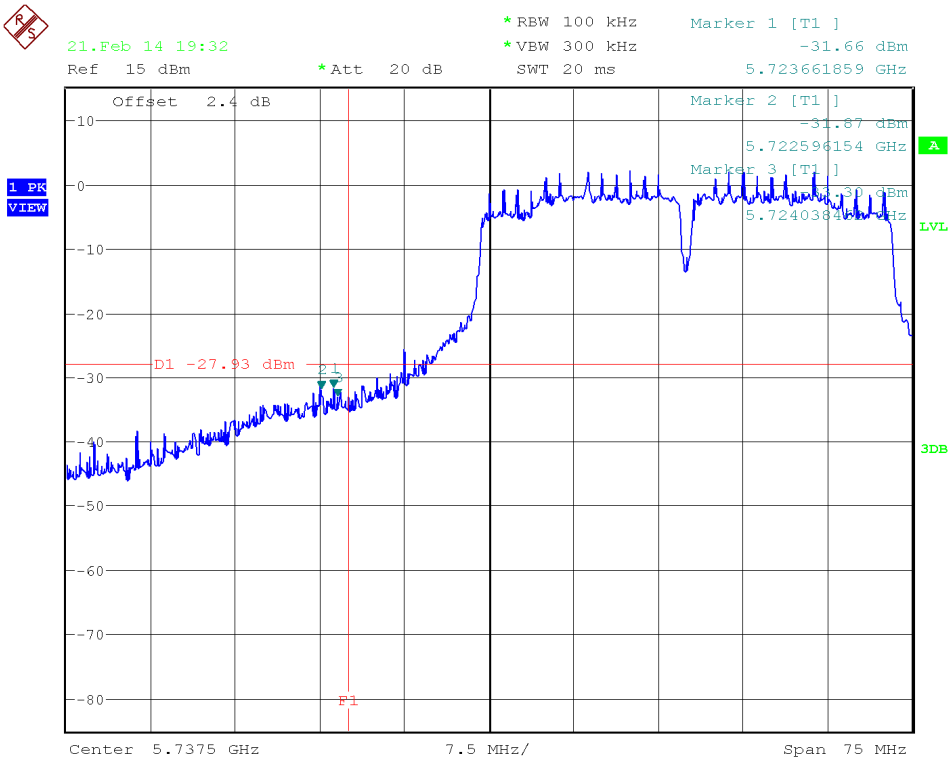
LOW FREQUENCY SECTION 5755 MHz. CONDUCTED.

See next plots.

Chain A



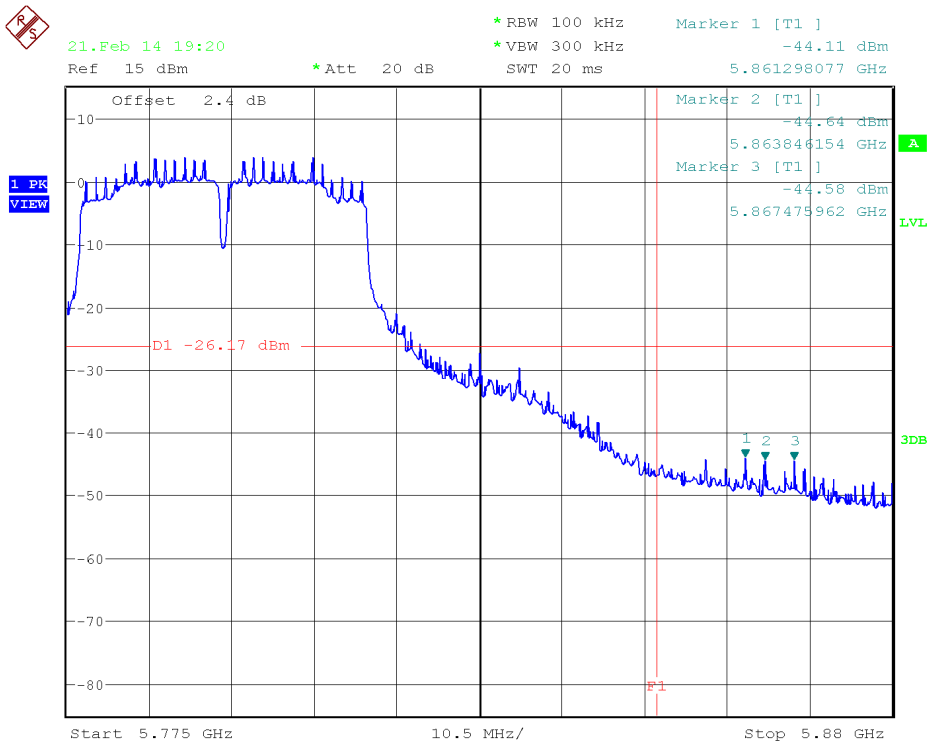
Chain B



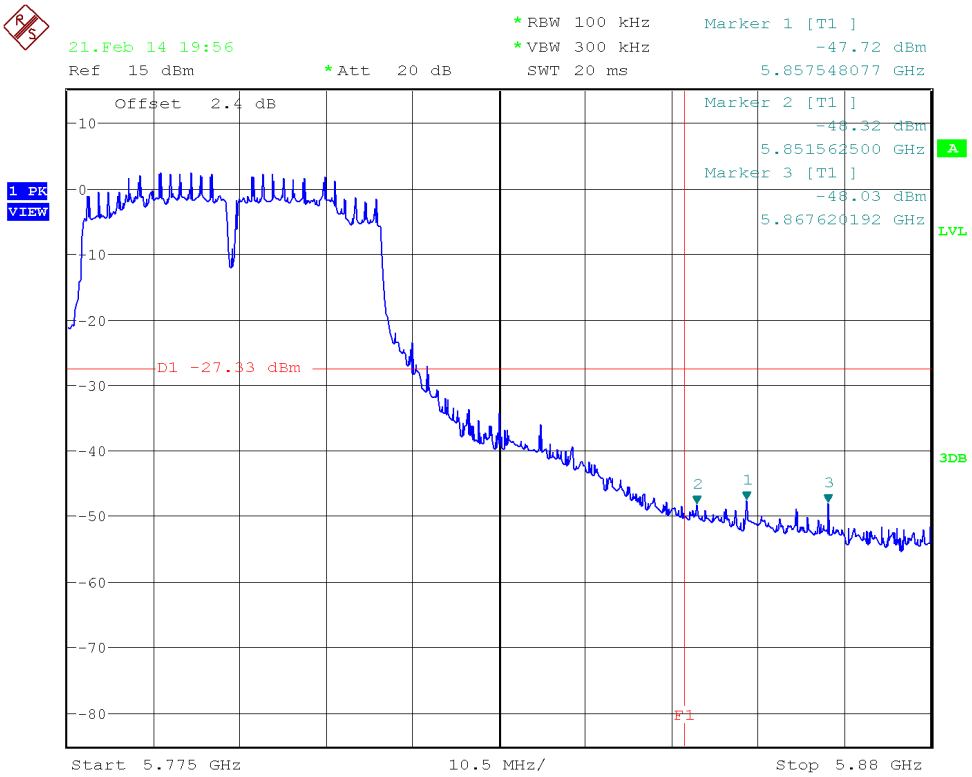
HIGH FREQUENCY SECTION 5795 MHz. CONDUCTED.

See next plots.

Chain A



Chain B



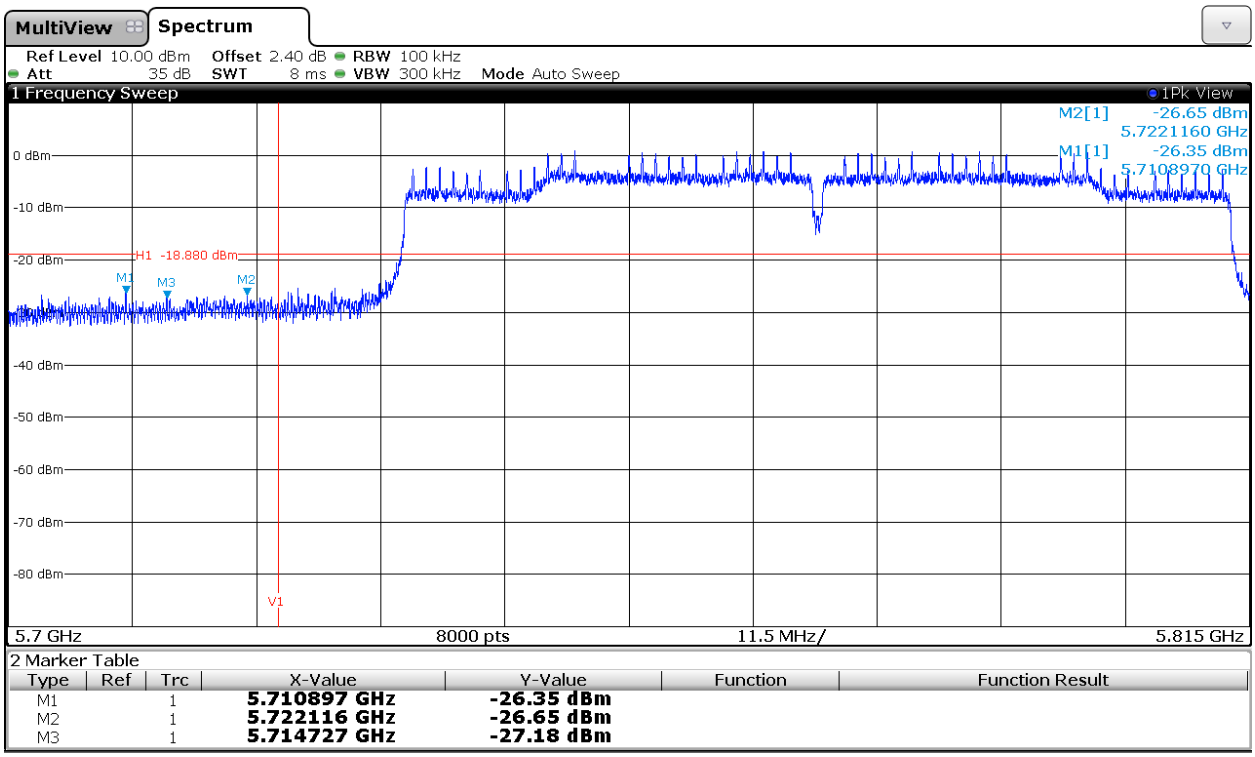
Verdict: PASS

4. WiFi 5GHz 802.11 ac80 mode

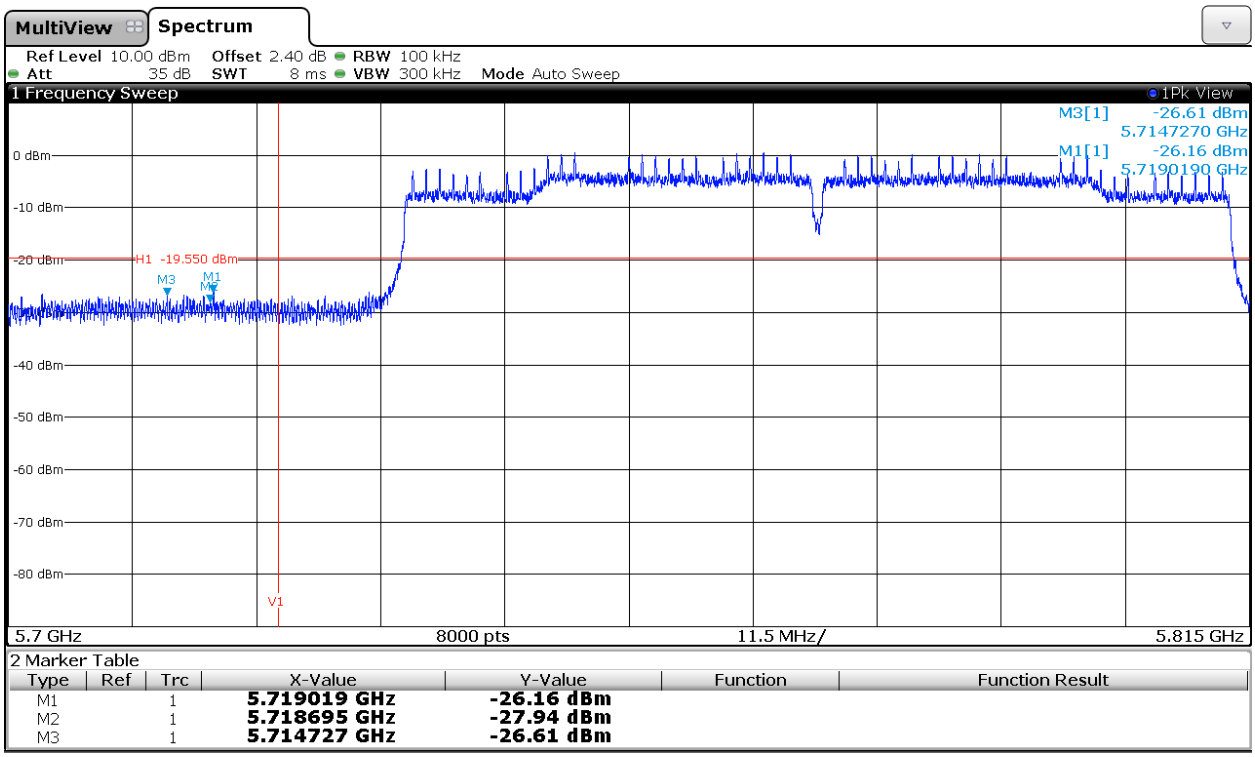
LOW FREQUENCY SECTION 5755 MHz. CONDUCTED.

See next plots.

Chain A



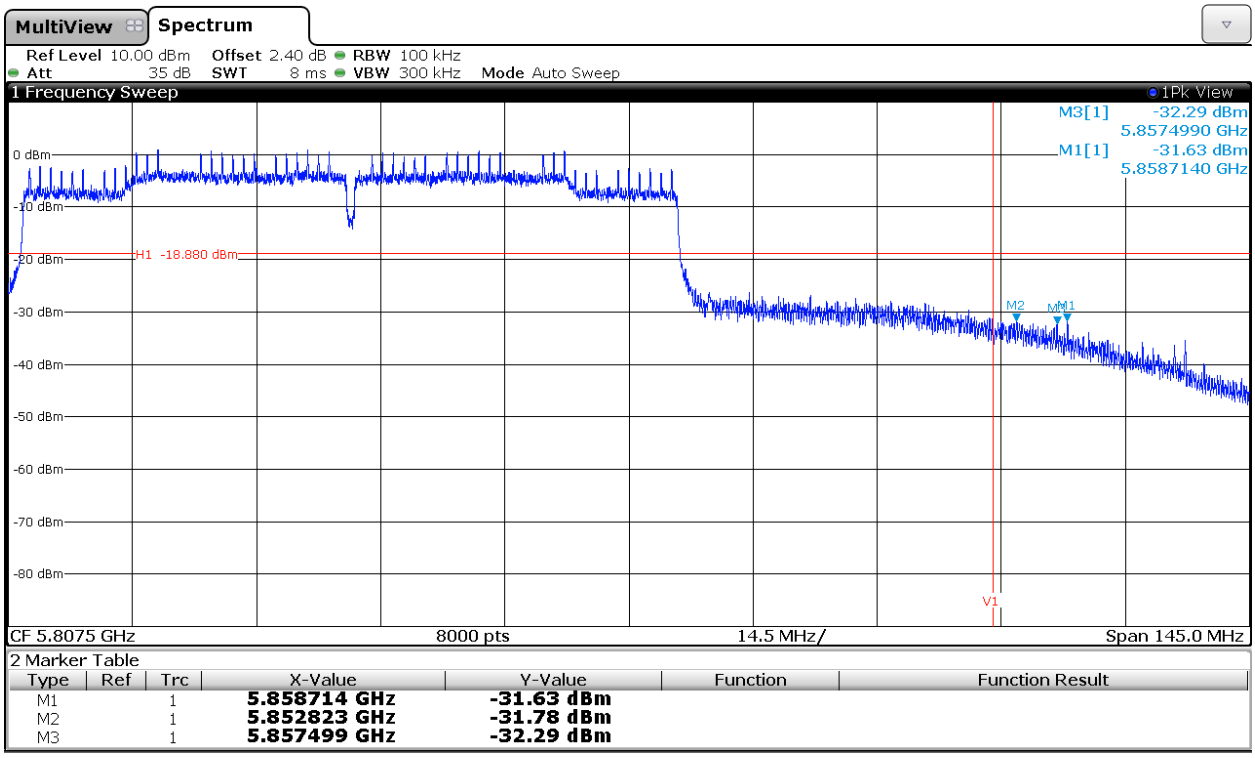
Chain B



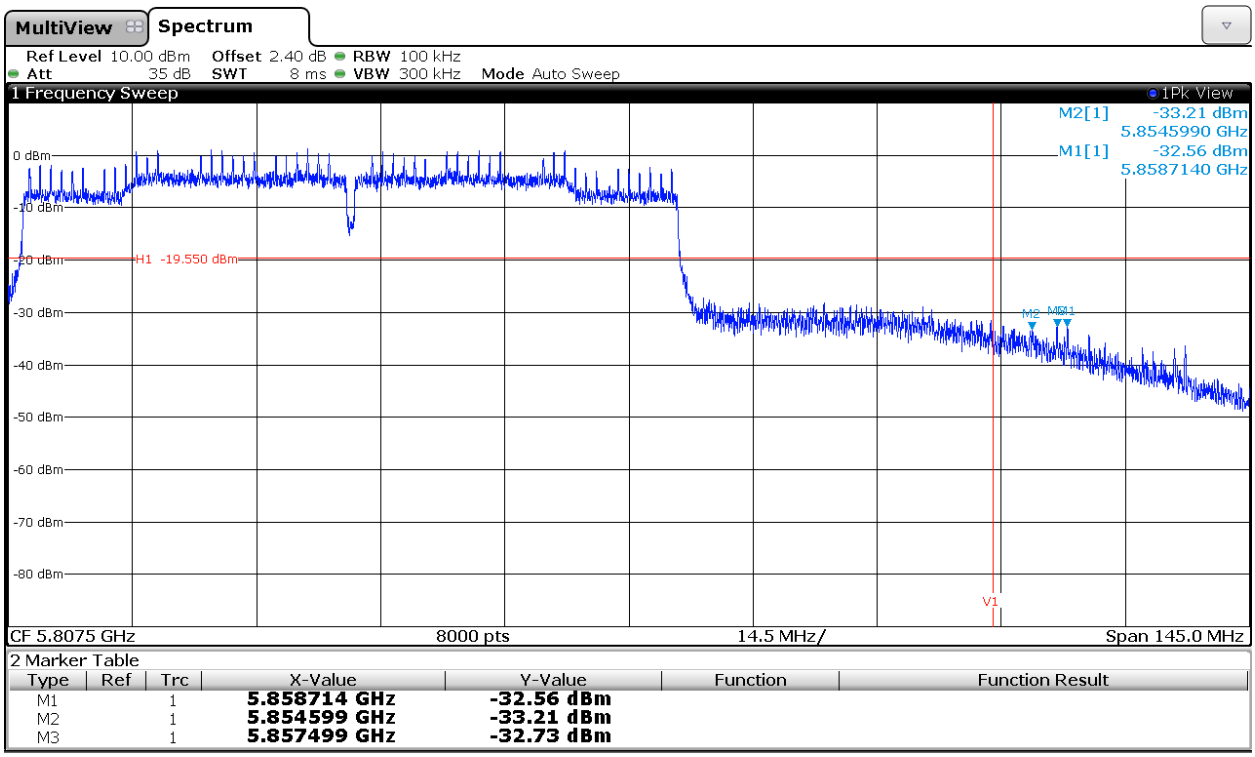
HIGH FREQUENCY SECTION 5775 MHz. CONDUCTED.

See next plots.

Chain A



Chain B



Verdict: PASS (NOTE: The limit is set to -20 dBc since the maximum peak conducted output power was measured for this mode.)

Section 15.247 Subclause (e) / RSS-210 A8.5. Power spectral density

SPECIFICATION

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

The maximum power spectral density level in the fundamental emission was measured using the method of trace averaging with EUT transmitting at full power throughout each sweep according to point 10.3. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r01 dated 09/04/2013. This method was used for 802.11a, 802.11n20 and 802.11n40 modes.
For 802.11ac80 mode the PKPSD (peak PSD) method was used since the maximum peak conducted output power was measured for this mode.

For MIMO mode, the *Measure and add 10 log(NANT) dB*, (where *NANT* is the number of outputs) technique was used according to the Guidance for Emission Testing of Transmitters with Multiple Outputs in the Same Band 662911 D01 Multiple Transmitter Output v02r01 dated 10/31/2013.
With this technique, spectrum measurements are performed at each output of the device, and the quantity *10 log(NANT)* dB is added to each spectrum value before comparing to the emission limit.
Number of outputs = 2.

1. WiFi 5GHz 802.11 a mode

Power spectral density (See next plots of worst case = highest level).

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
Power spectral density (dBm)	-3.940	-4.630	-3.899	-3.725	-4.257	-4.075
Measurement uncertainty (dB)	±1.5					

Verdict: PASS

2. WiFi 5GHz 802.11 n20 mode

Power spectral density (See next plots of worst case = highest level).

	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A	Chain B	Chain A	Chain B	Chain A	Chain B
Power spectral density (dBm)	-5.059	-5.659	-3.974	-4.989	-4.627	-4.524
Measurement uncertainty (dB)	±1.5					

MIMO	Lowest frequency 5745 MHz		Middle frequency 5785 MHz		Highest frequency 5825 MHz	
	Chain A+B		Chain A+B		Chain A+B	
	Port A	Port B	Port A	Port B	Port A	Port B
Power spectral density (dBm)	-7.140	-7.367	-6.669	-7.185	-6.613	-6.482
Power spectral density (dBm) + 10*Log(2)	-4.29	-4.98	-3.00	-3.11	-3.33	-3.99
Measurement uncertainty (dB)	±1.5					

Verdict: PASS

3. WiFi 5GHz 802.11 n40 mode

Power spectral density (See next plots of worst case = highest level).

	Lowest frequency 5755 MHz		Highest frequency 5795 MHz	
	Chain A	Chain B	Chain A	Chain B
Power spectral density (dBm)	-6.887	-6.644	-6.531	-6.604
Measurement uncertainty (dB)	±1.5			

MIMO	Lowest frequency 5755 MHz		Highest frequency 5795 MHz	
	Chain A+B		Chain A+B	
	Port A	Port B	Port A	Port B
Power spectral density (dBm)	-5.868	-5.464	-5.602	-5.848
Power spectral density (dBm) + 10*Log(2)	-2.86	-2.45	-2.59	-2.84
Measurement uncertainty (dB)	±1.5			

Verdict: PASS

4. WiFi 5GHz 802.11 ac80 mode

Power spectral density (See next plots of worst case = highest level).

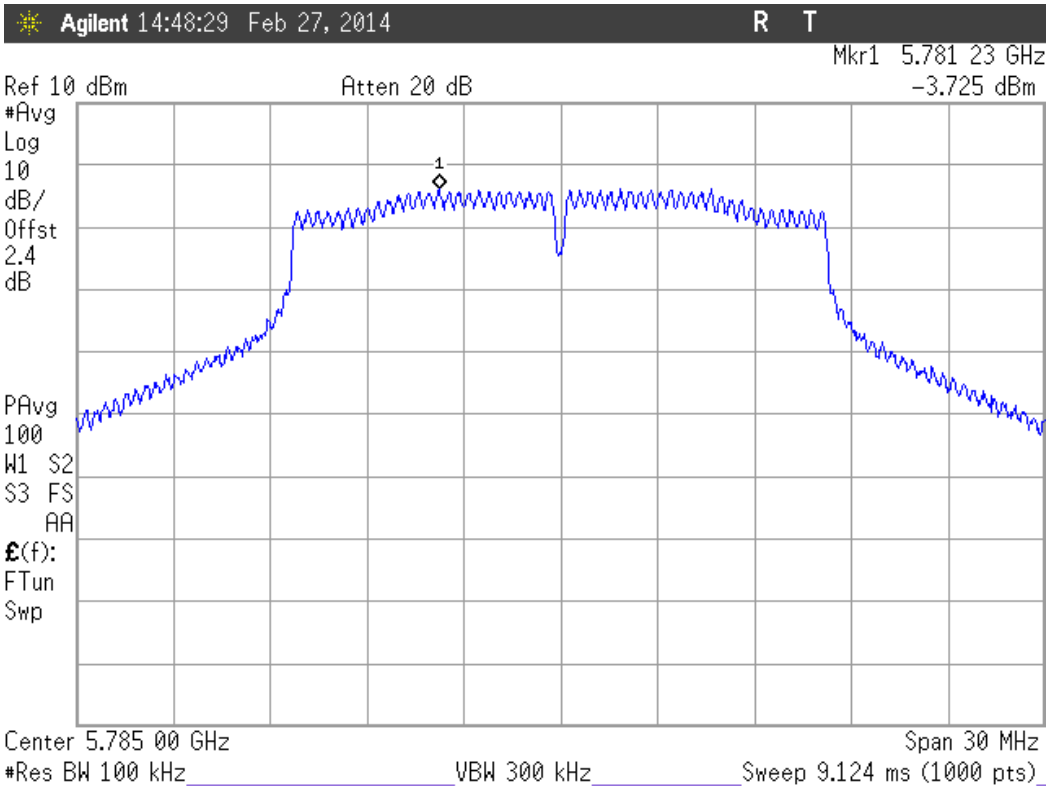
SISO	Middle frequency 5775 MHz	
	Chain A	Chain B
Power spectral density (dBm)	0.54	0.79
Measurement uncertainty (dB)	±1.2	

MIMO	Lowest frequency 5755 MHz	
	Chain A+B	
	Port A	Port B
Power spectral density (dBm)	1.24	1.55
Power spectral density (dBm) + 10*Log(2)	4.25	4.56
Measurement uncertainty (dB)	±1.2	

Verdict: PASS (NOTE: the PKPSD (peak PSD) method was used since the maximum peak conducted output power was measured for this mode).

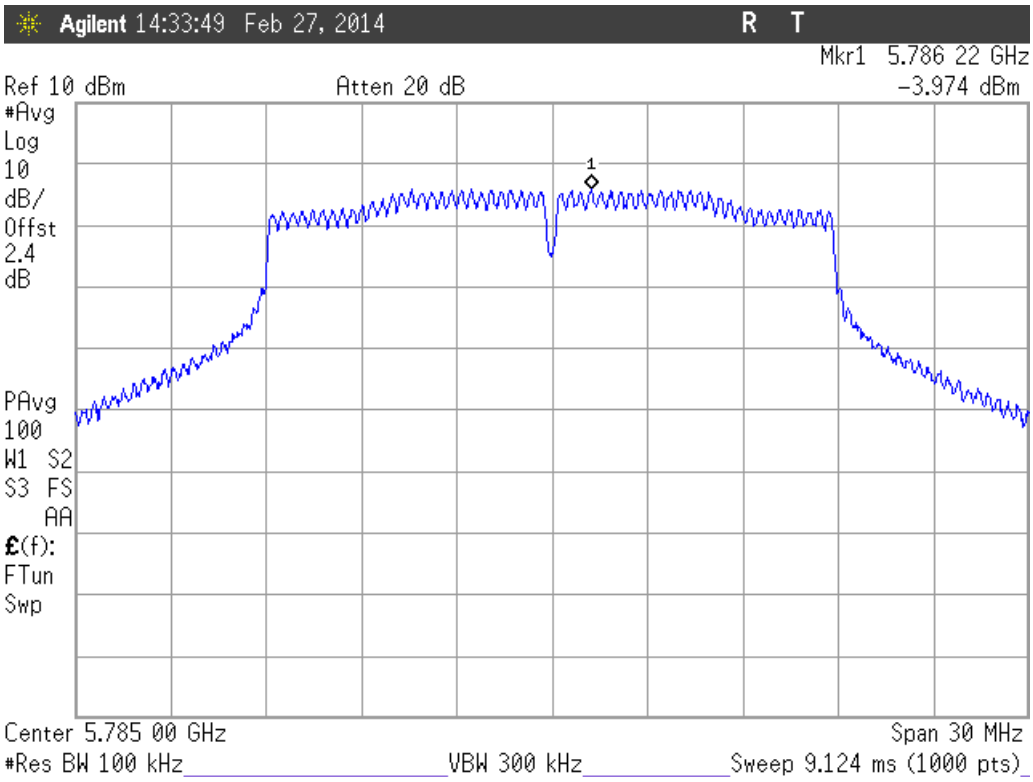
1. WiFi 5GHz 802.11 a mode

Middle Channel: 5785 MHz. Chain B.

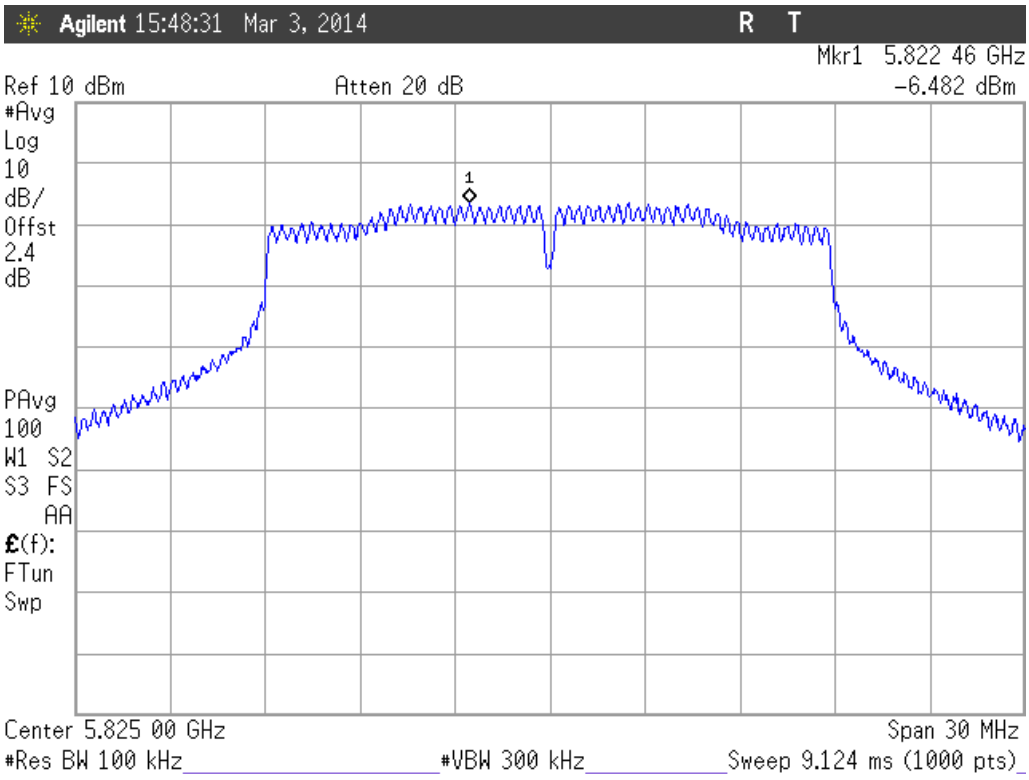


2. WiFi 5GHz 802.11 n20 mode

SISO. Middle Channel: 5785 MHz. Chain A.

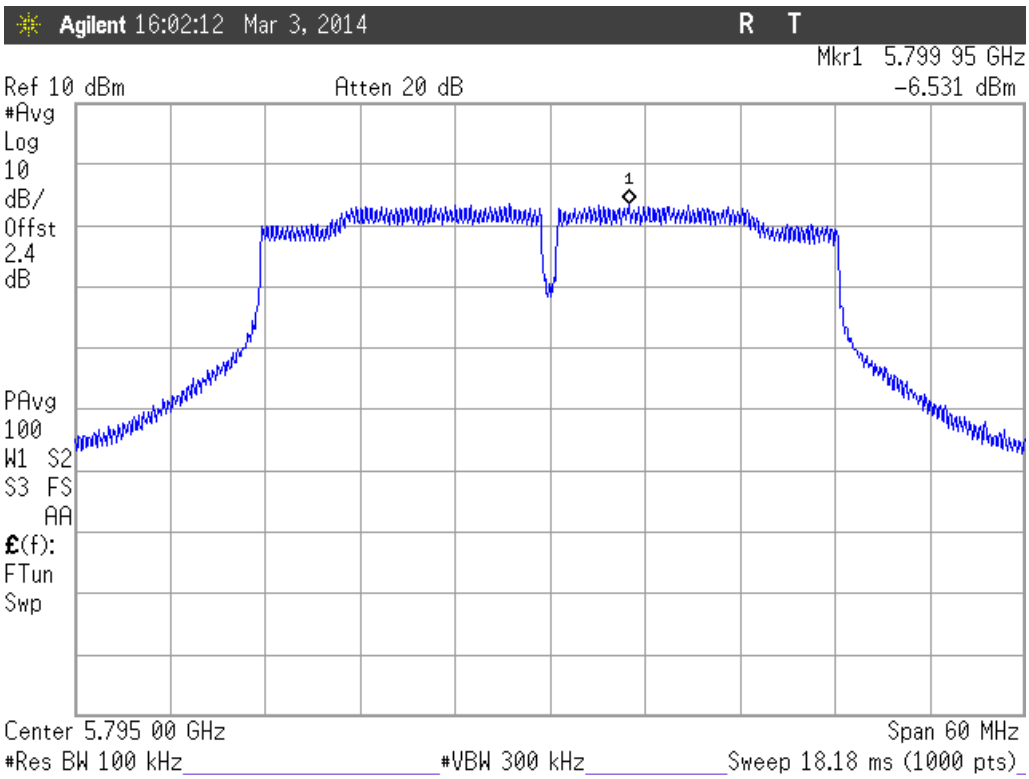


MIMO. Highest Channel: 5825 MHz. Chain A+B. Port B.

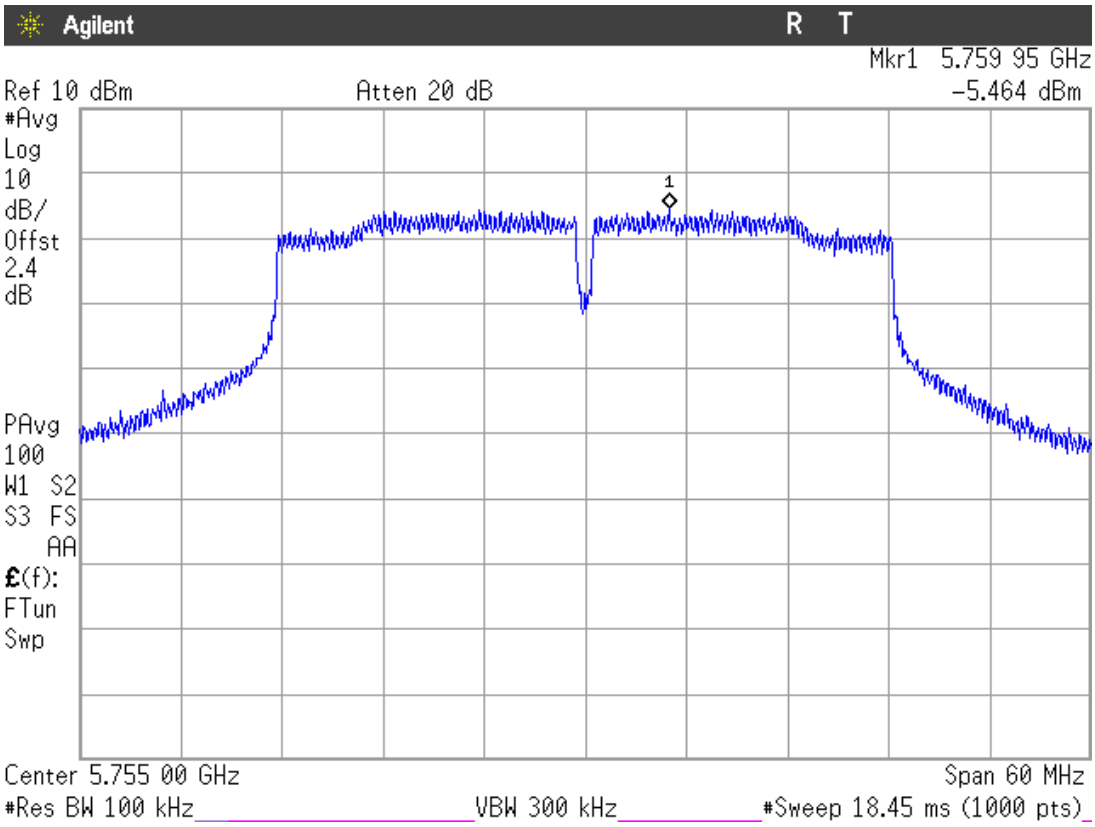


3. WiFi 5GHz 802.11 n40 mode

SISO. Highest frequency 5795 MHz. Chain A.

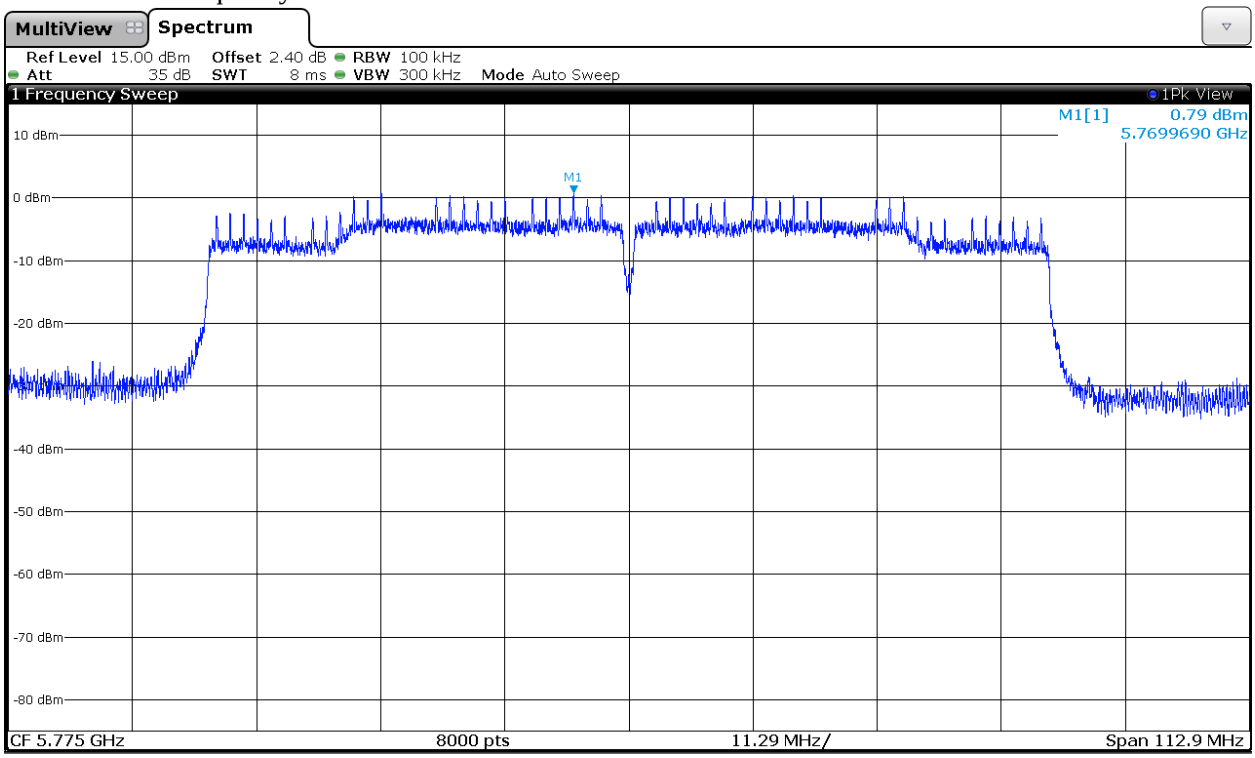


MIMO. Lowest frequency 5755 MHz. Chain A+B. Port B.

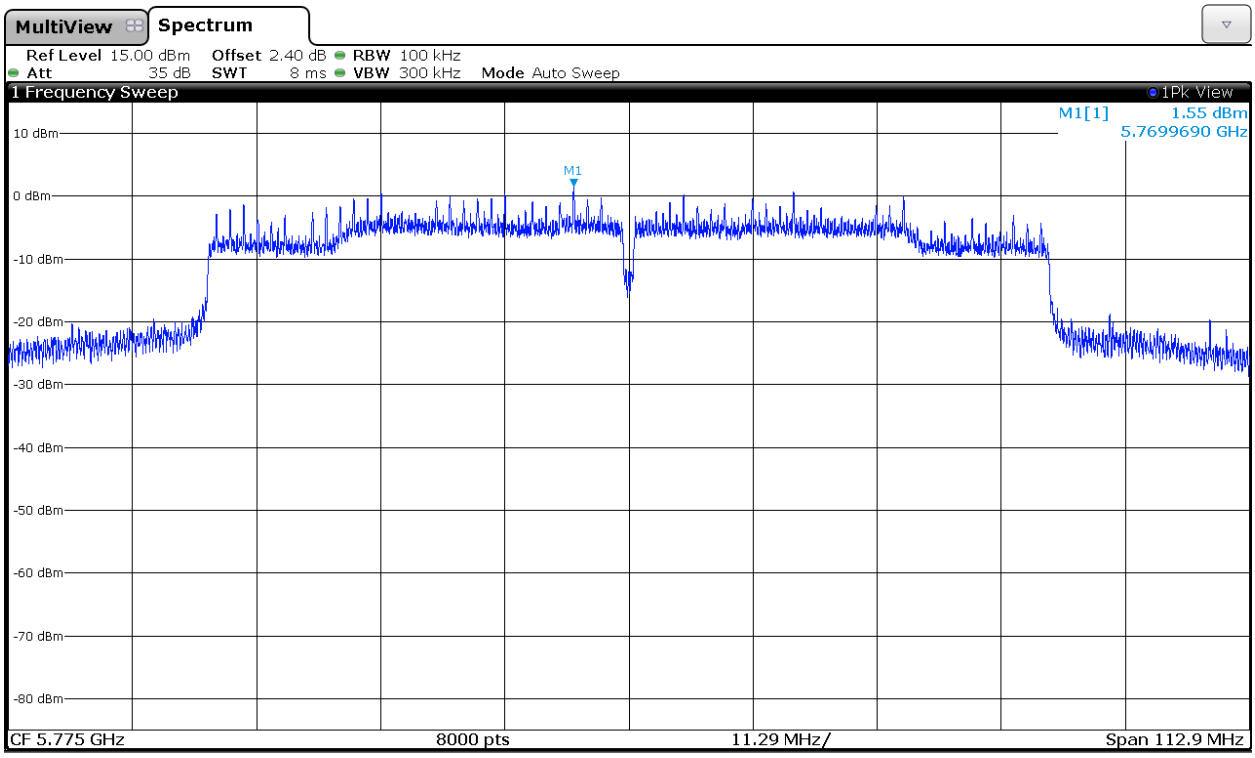


4. WiFi 5GHz 802.11 ac80 mode

SISO. Middle frequency 5775 MHz. Chain B.



MIMO. Middle frequency 5775 MHz. Chain A+B. Port B.



Section 15.247 Subclause (d) / RSS-210 A8.5. Emission limitations radiated (Transmitter)

SPECIFICATION

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 360º 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 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-40 GHz.

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-1000 MHz.

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

See test results in Appendix A for details.

Frequency range 1 GHz-40 GHz.

For the 4 OFDM modulation modes (802.11a, 802.11n20, 802.11n40 and 802.11ac80), a preliminary measurement in the central channel was performed in the range 1-18 GHz to determine the worst case. The lowest and highest channels were measured for out-of-band emissions for the worst case (802.11n20).

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

1. WiFi 5GHz 802.11 a mode

Middle frequency 5785 MHz.

Chain A

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5700	PV	Peak	52.26	± 4.00
17.3583	PV	Peak	66.33	± 4.00
		Average	53.76	± 4.00
23.1395	PV	Peak	52.36	± 4.00

Chain B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5678	PV	Peak	56.54	± 4.00
		Average	45.88	± 4.00
17.3550	PV	Peak	63.96	± 4.00
		Average	52.28	± 4.00
23.1405	PV	Peak	51.26	± 4.00

2. WiFi 5GHz 802.11 n20 mode

Lowest frequency 5745 MHz.

Chain A

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.4899	PV	Peak	49.82	± 4.00
17.2343	PV	Peak	64.41	± 4.00
		Average	52.73	± 4.00
22.9795	PV	Peak	54.36	± 4.00
		Average	49.04	± 4.00

Chain B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.4900	PV	Peak	57.13	± 4.00
		Average	46.35	± 4.00
17.2341	PV	Peak	63.13	± 4.00
		Average	51.09	± 4.00
22.9795	PV	Peak	53.53	± 4.00

Chain A+B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.4906	PV	Peak	55.88	± 4.00
		Average	43.79	± 4.00
17.2391	PV	Peak	63.26	± 4.00
		Average	48.23	± 4.00
22.9805	PV	Peak	52.67	± 4.00

Middle frequency 5785 MHz.

Chain A

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5714	PV	Peak	51.82	± 4.00
17.3524	PV	Peak	66.47	± 4.00
		Average	53.84	± 4.00
23.1395	PV	Peak	53.11	± 4.00

Chain B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5701	PV	Peak	57.32	± 4.00
		Average	45.96	± 4.00
17.3558	PV	Peak	65.05	± 4.00
		Average	52.30	± 4.00
23.1405	PV	Peak	51.59	± 4.00

Chain A+B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5692	PV	Peak	53.70	± 4.00
17.3509	PV	Peak	65.01	± 4.00
		Average	49.36	± 4.00
23.1405	PV	Peak	52.31	± 4.00

Highest frequency 5825 MHz.

Chain A

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
17.4768	PV	Peak	65.33	± 4.00
		Average	53.74	± 4.00
23.3005	PV	Peak	51.12	± 4.00

Chain B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.6509	PV	Peak	55.96	± 4.00
		Average	46.34	± 4.00
17.4754	PV	Peak	52.81	± 4.00
23.3005	PV	Peak	51.65	± 4.00

Chain A+B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.6496	PV	Peak	53.07	± 4.00
17.48785	PV	Peak	63.71	± 4.00
		Average	51.11	± 4.00
23.3005	PV	Peak	52.18	± 4.00

3. WiFi 5GHz 802.11 n40 mode

Highest frequency 5795 MHz.

Chain A

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
17.3792	PV	Peak	62.66	± 4.00
		Average	51.99	± 4.00
23.1795	PV	Peak	52.59	± 4.00

Chain B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
11.5891	PV	Peak	56.09	± 4.00
		Average	44.29	± 4.00
17.3778	PV	Peak	60.27	± 4.00
		Average	48.84	± 4.00
23.1795	PV	Peak	52.18	± 4.00

Chain A+B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
11.5863	PV	Peak	53.34	± 4.00
17.3778	PV	Peak	63.54	± 4.00
		Average	52.78	± 4.00
23.1795	PV	Peak	52.76	± 4.00

4. WiFi 5GHz 802.11 ac80 mode

Middle frequency 5775 MHz

Chain A

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
17.3723	PV	Peak	62.54	± 4.00
		Average	49.78	± 4.00
23.0995	PV	Peak	54.12	± 4.00
		Average	47.16	± 4.00

Chain B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
11.5506	PV	Peak	54.2	± 4.00
		Average	42.26	± 4.00
17.3723	PV	Peak	62.58	± 4.00
		Average	49.78	± 4.00
23.0995	PV	Peak	52.73	± 4.00

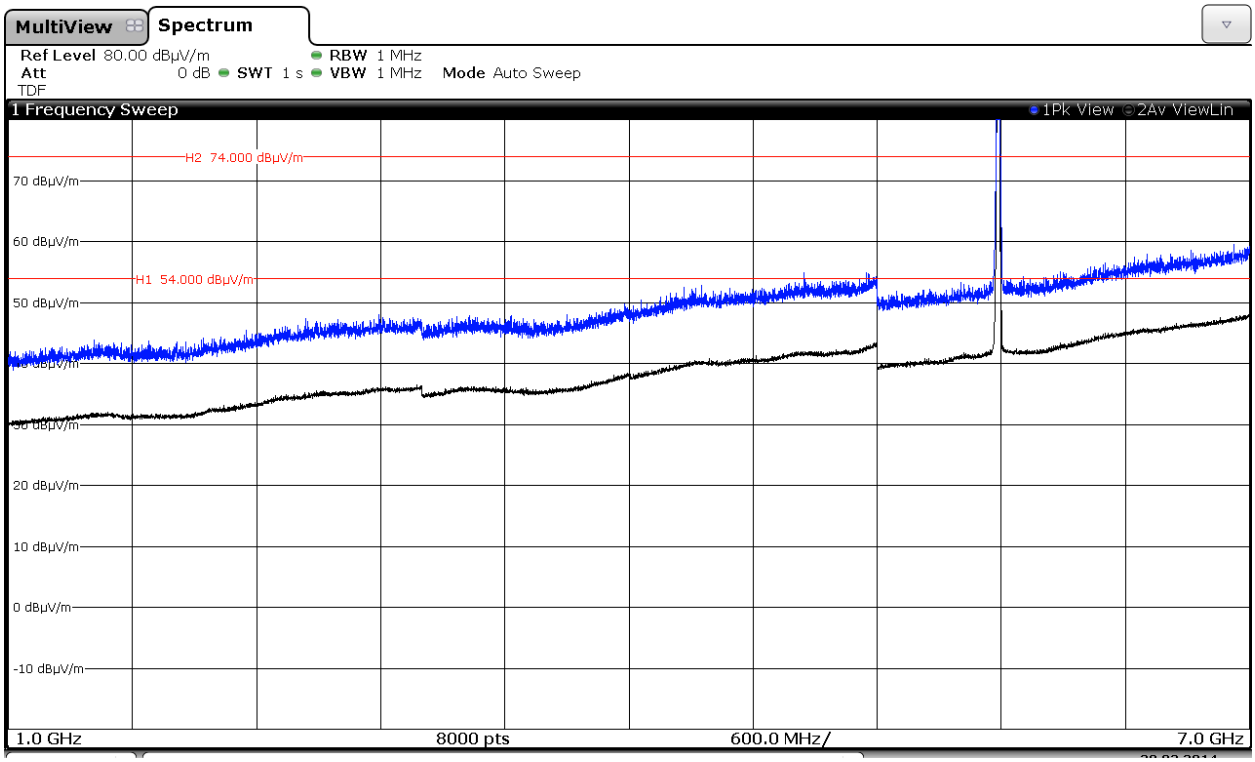
Chain A+B

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
11.5203	PV	Peak	54.31	± 4.00
		Average	41.74	± 4.00
17.3132	PV	Peak	61.88	± 4.00
		Average	50.06	± 4.00
23.0995	PV	Peak	56.12	± 4.00
		Average	49.54	± 4.00

FREQUENCY RANGE 1 GHz to 7 GHz.

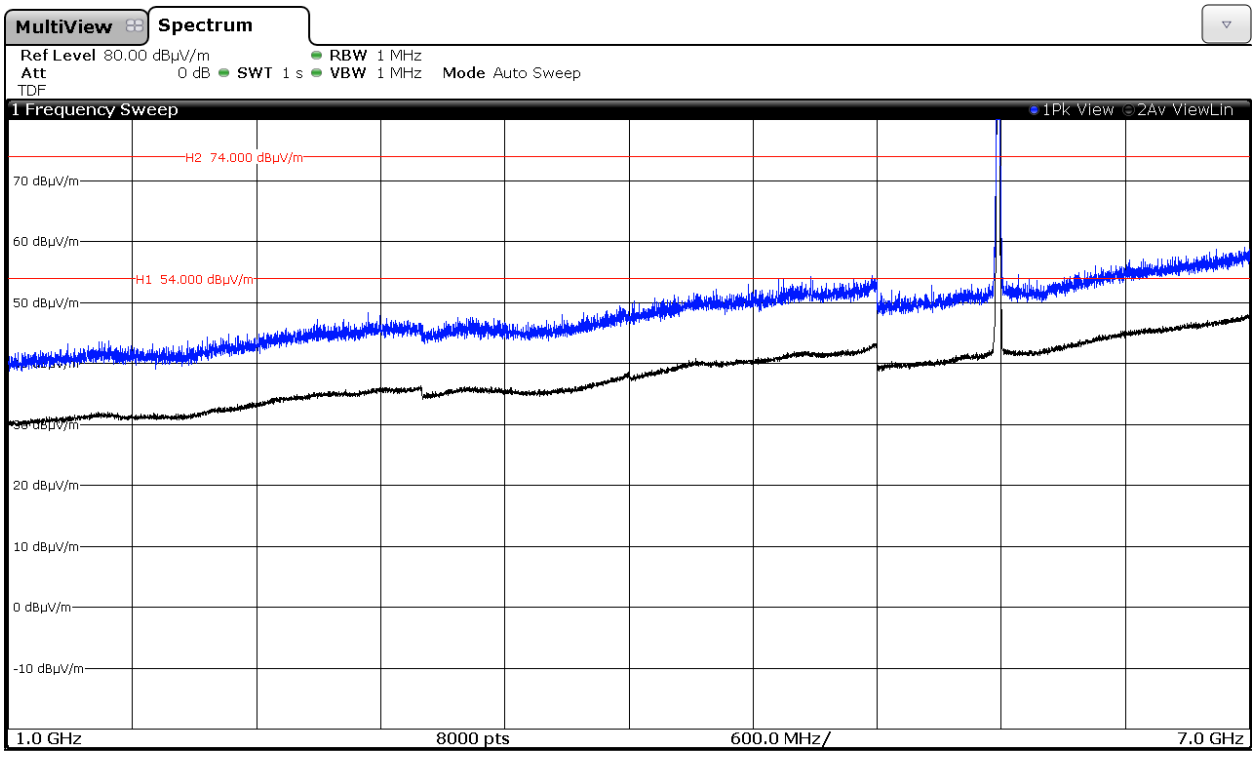
1. WiFi 5GHz 802.11 a mode

Middle Channel: 5785 MHz. Chain A



Note: The peak above the limit is the carrier frequency.

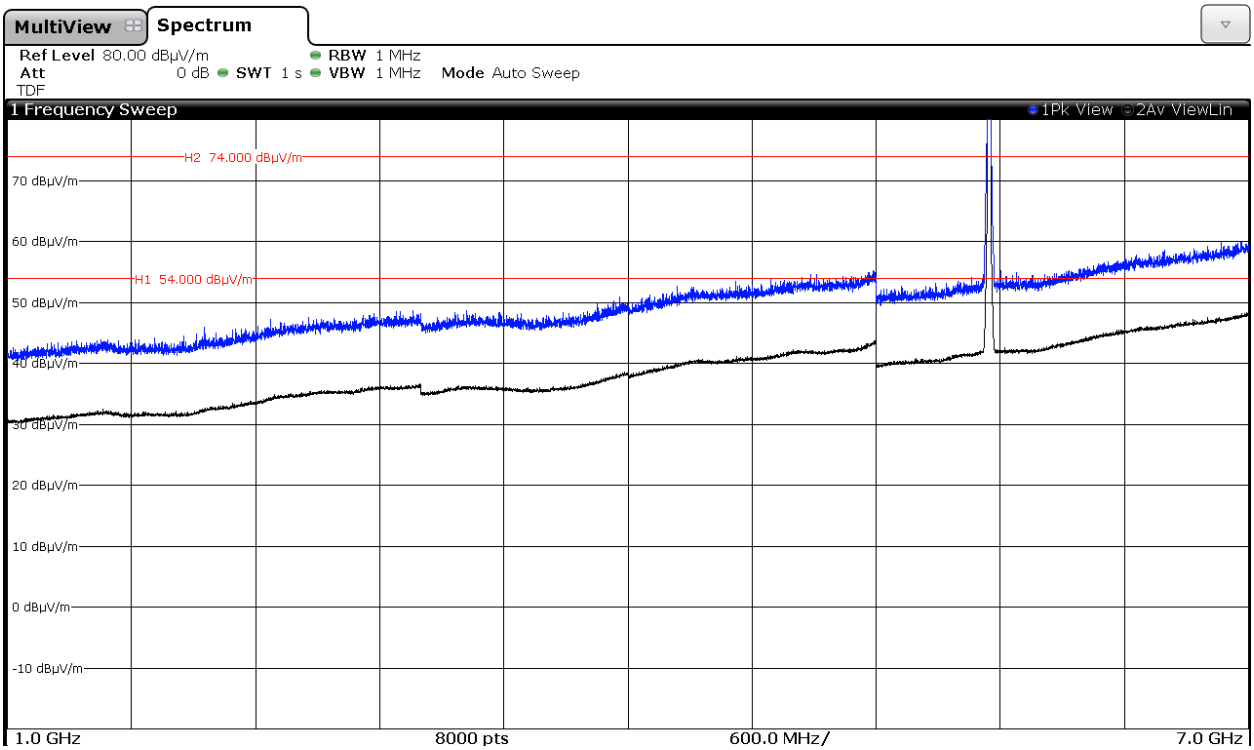
Middle Channel: 5785 MHz. Chain B



Note: The peak above the limit is the carrier frequency.

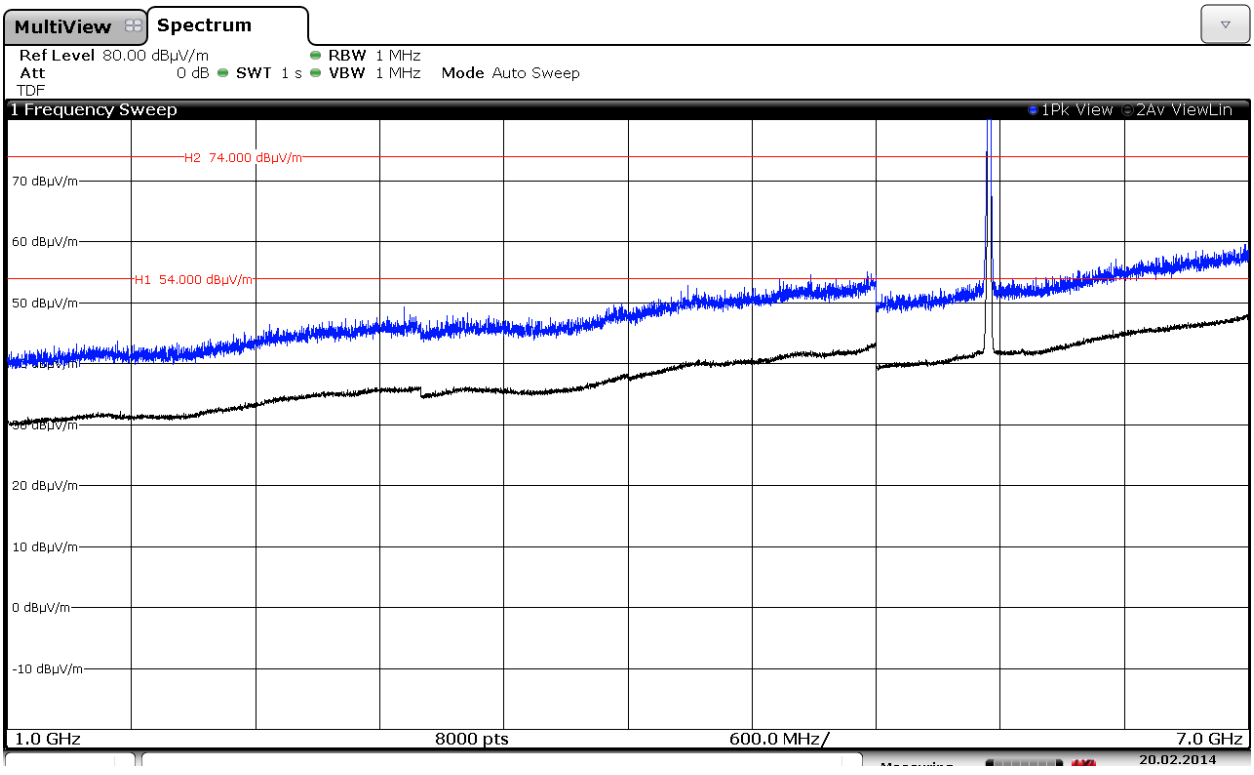
2. WiFi 5GHz 802.11 n20 mode

Lowest Channel: 5745 MHz. Chain A



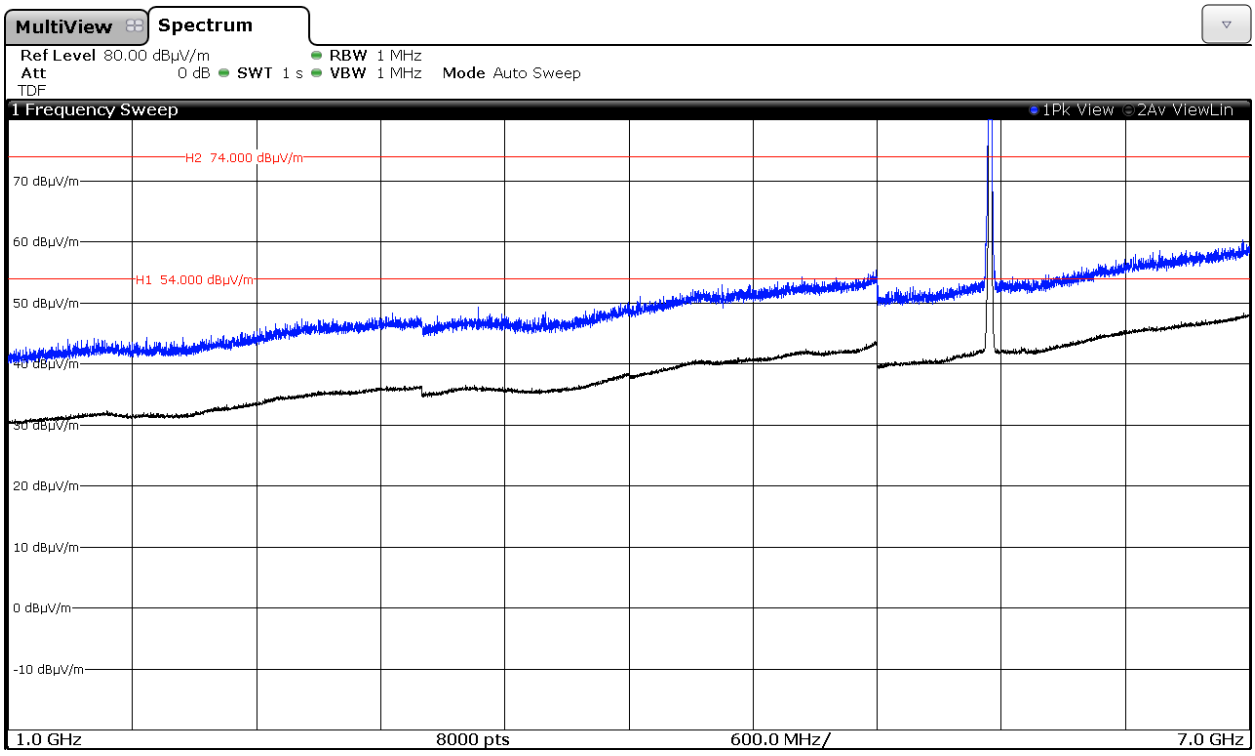
Note: The peak above the limit is the carrier frequency.

Lowest Channel: 5745 MHz. Chain B



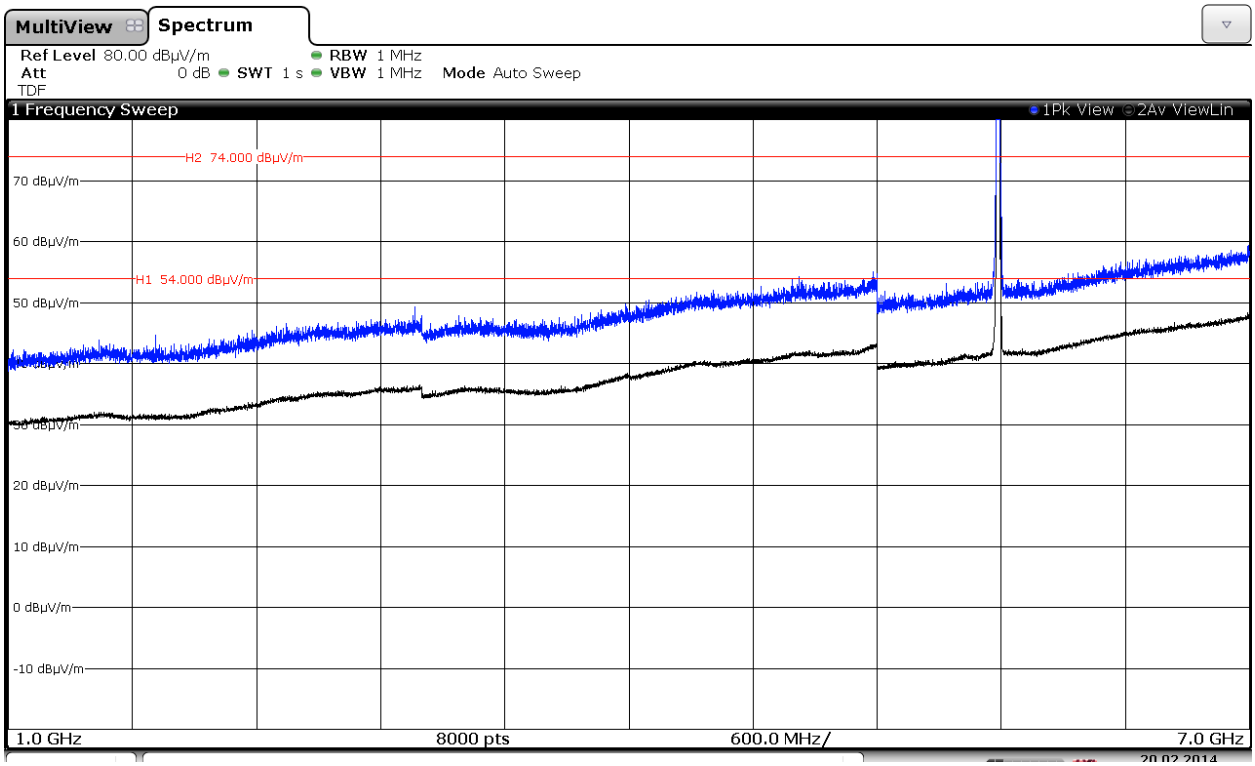
Note: The peak above the limit is the carrier frequency.

Lowest Channel: 5745 MHz. Chain A+B



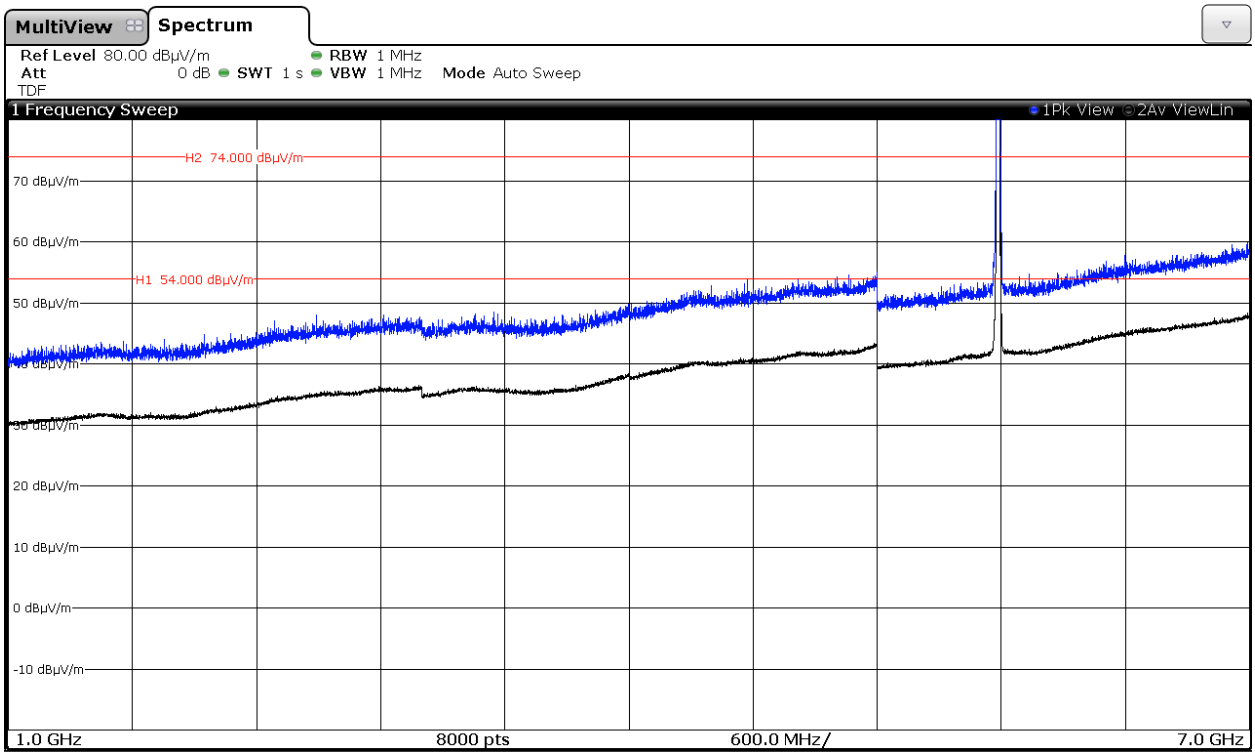
Note: The peak above the limit is the carrier frequency.

Middle Channel: 5785 MHz. Chain A



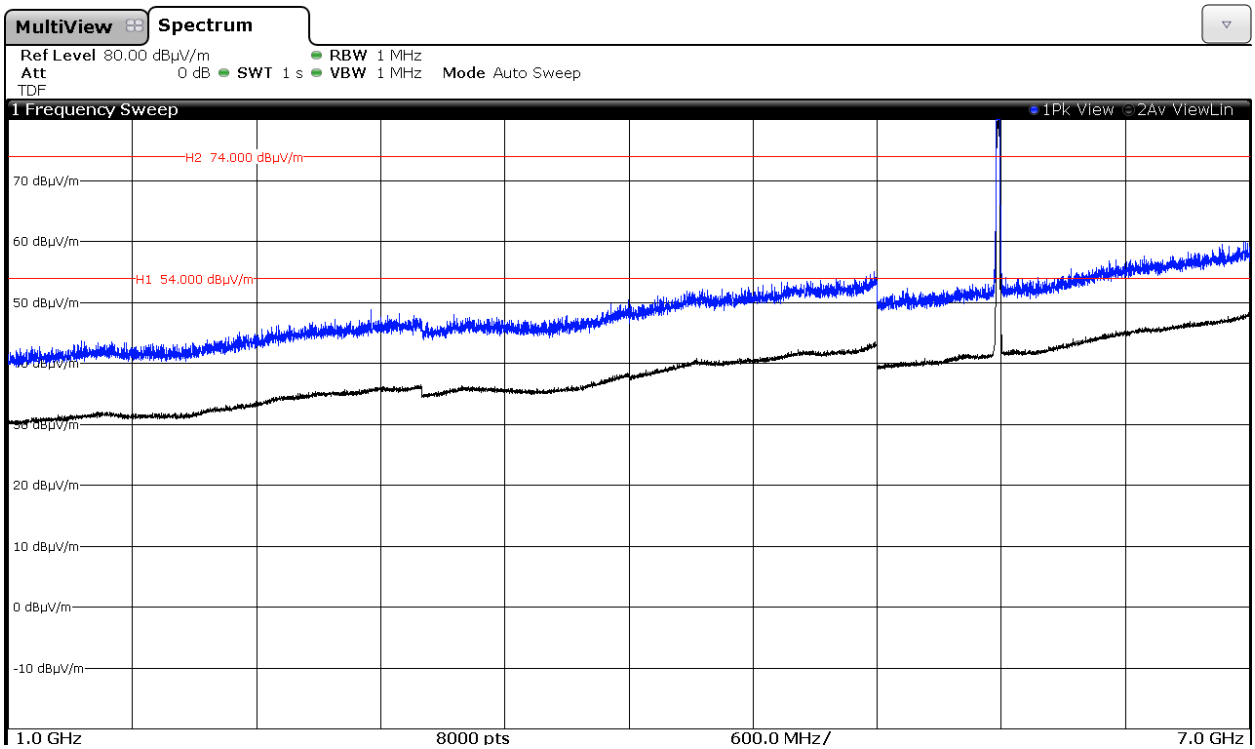
Note: The peak above the limit is the carrier frequency.

Middle Channel: 5785 MHz. Chain B



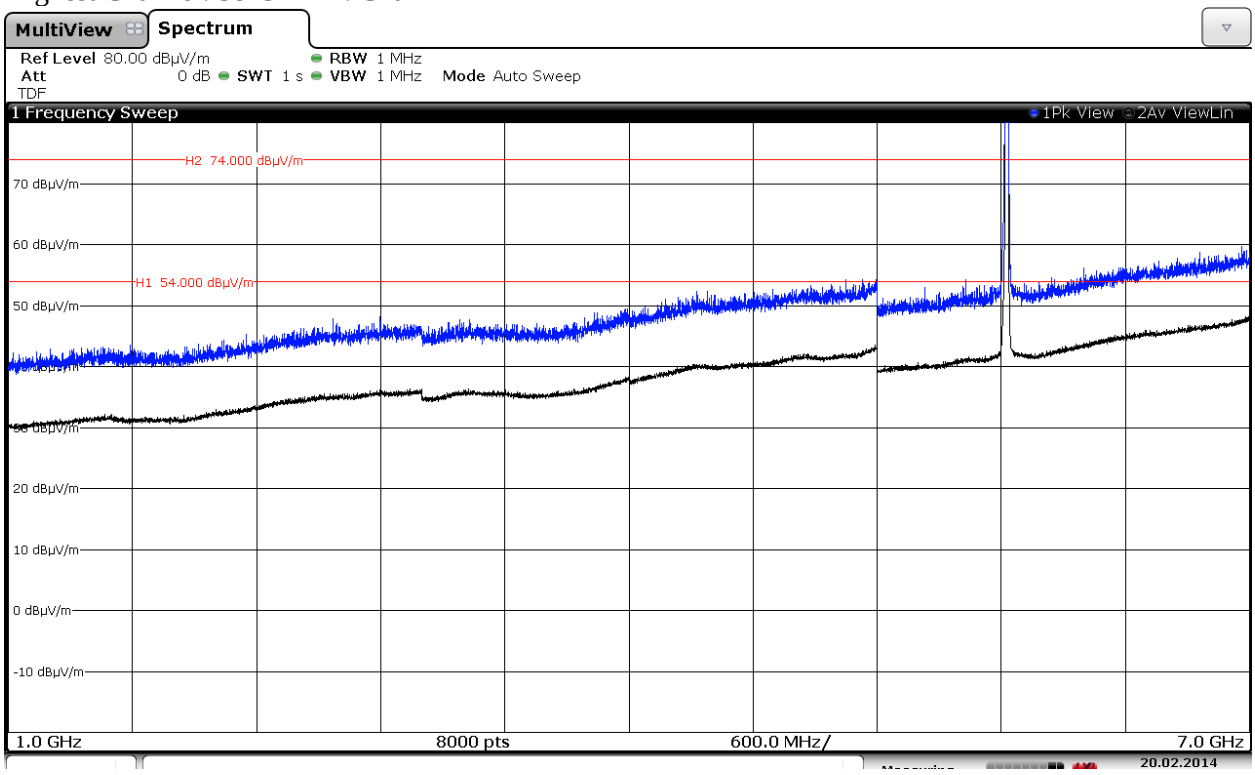
Note: The peak above the limit is the carrier frequency.

Middle Channel: 5785 MHz. Chain A+B



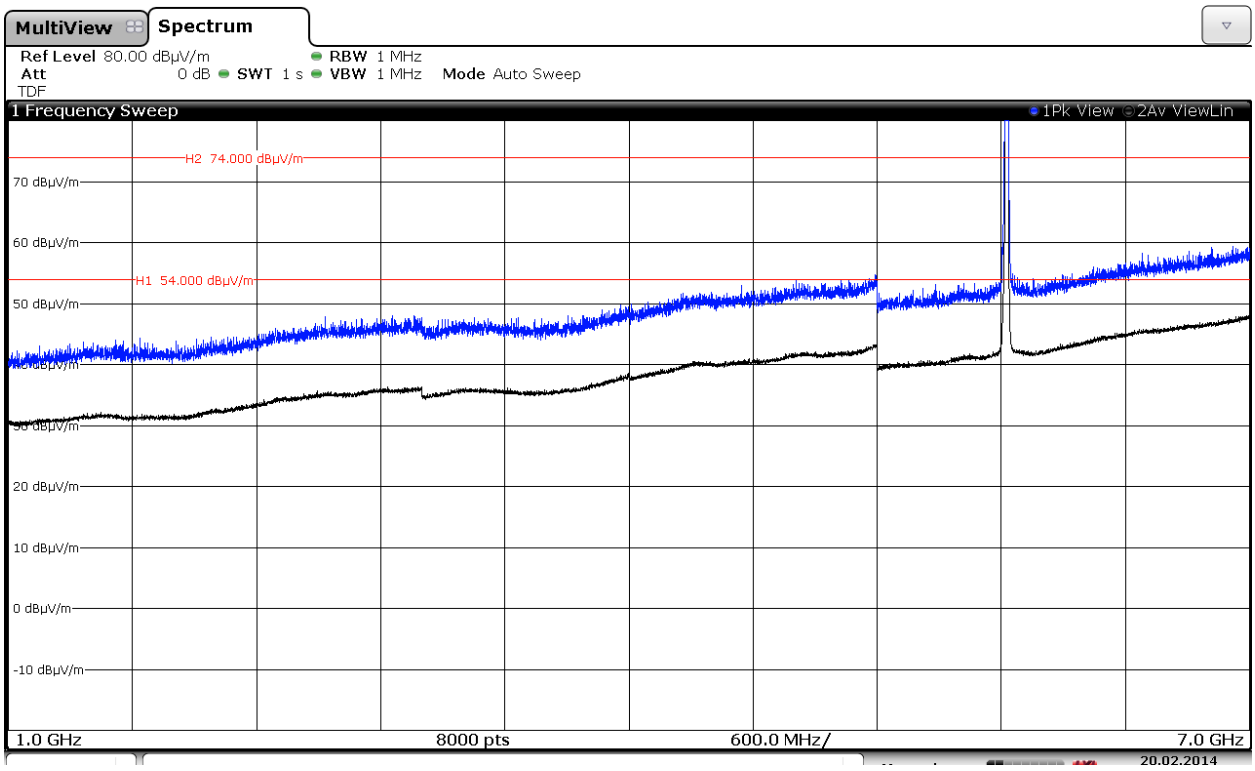
Note: The peak above the limit is the carrier frequency.

Highest Channel: 5825 MHz. Chain A



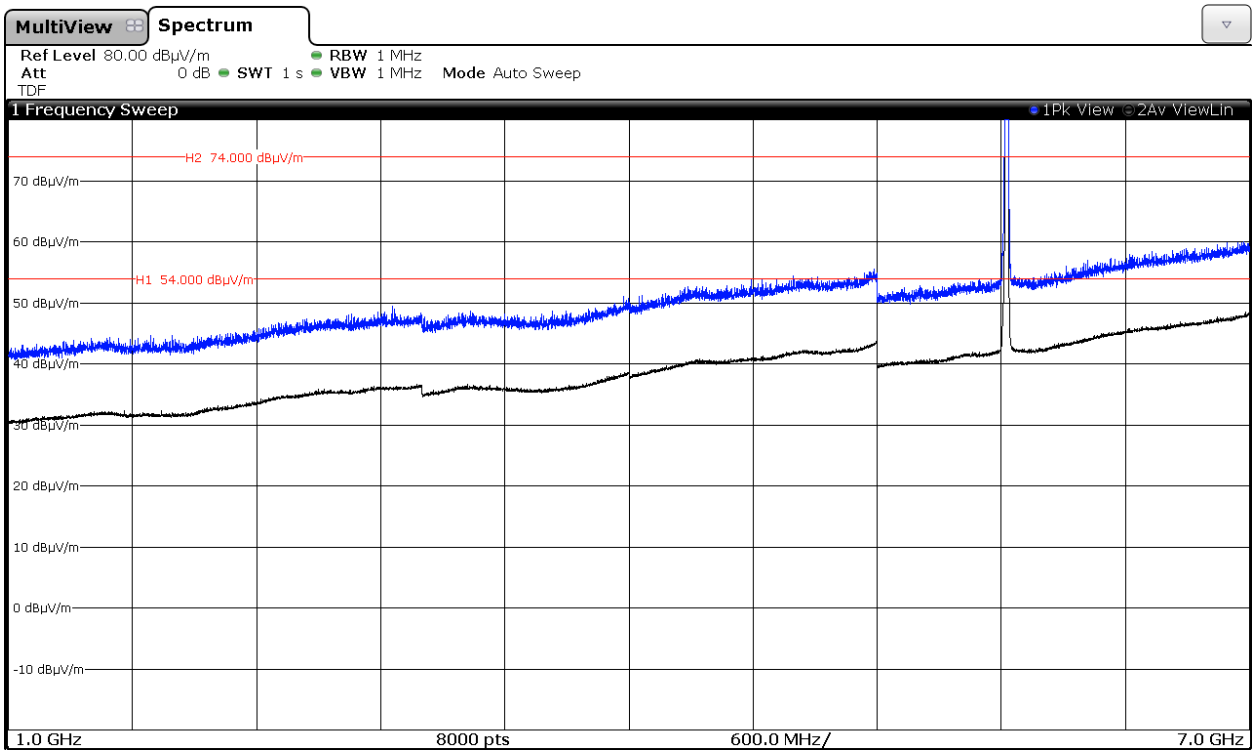
Note: The peak above the limit is the carrier frequency.

Highest Channel: 5825 MHz. Chain B



Note: The peak above the limit is the carrier frequency.

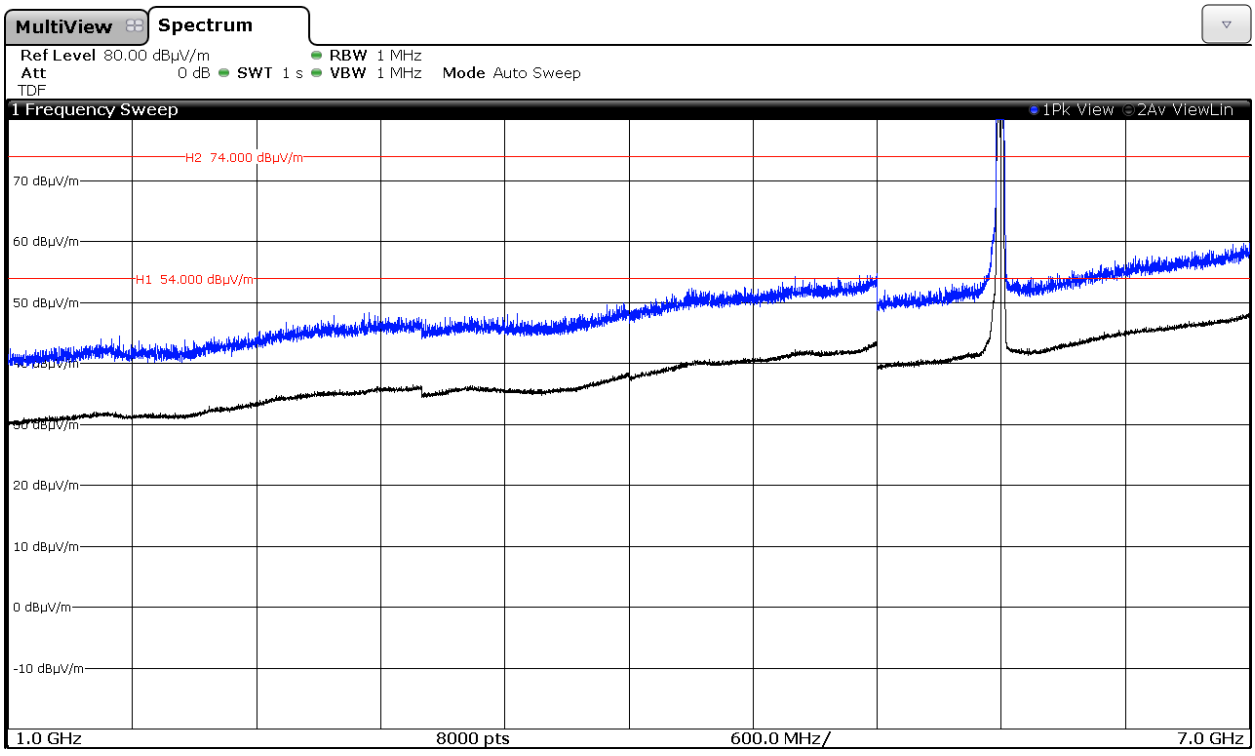
Highest Channel: 5825 MHz. Chain A+B



Note: The peak above the limit is the carrier frequency.

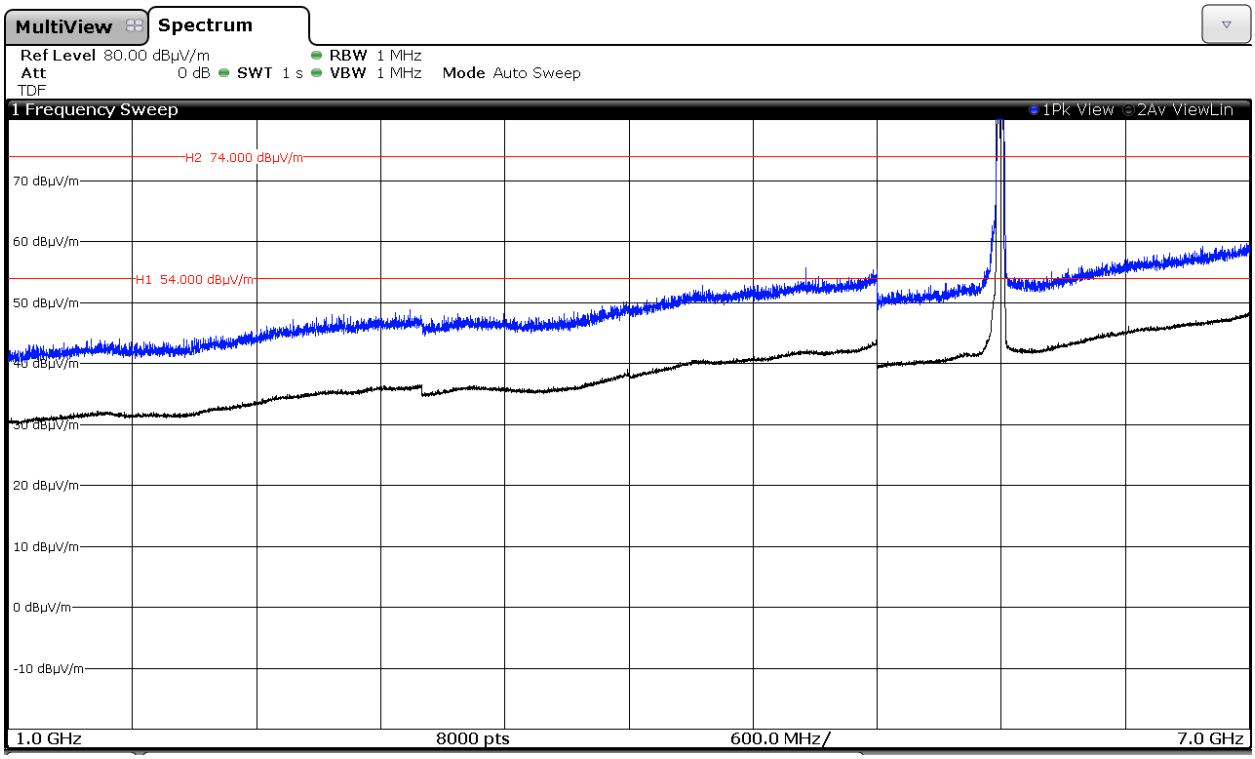
3. WiFi 5GHz 802.11 n40 mode

Highest Channel: 5795 MHz. Chain A



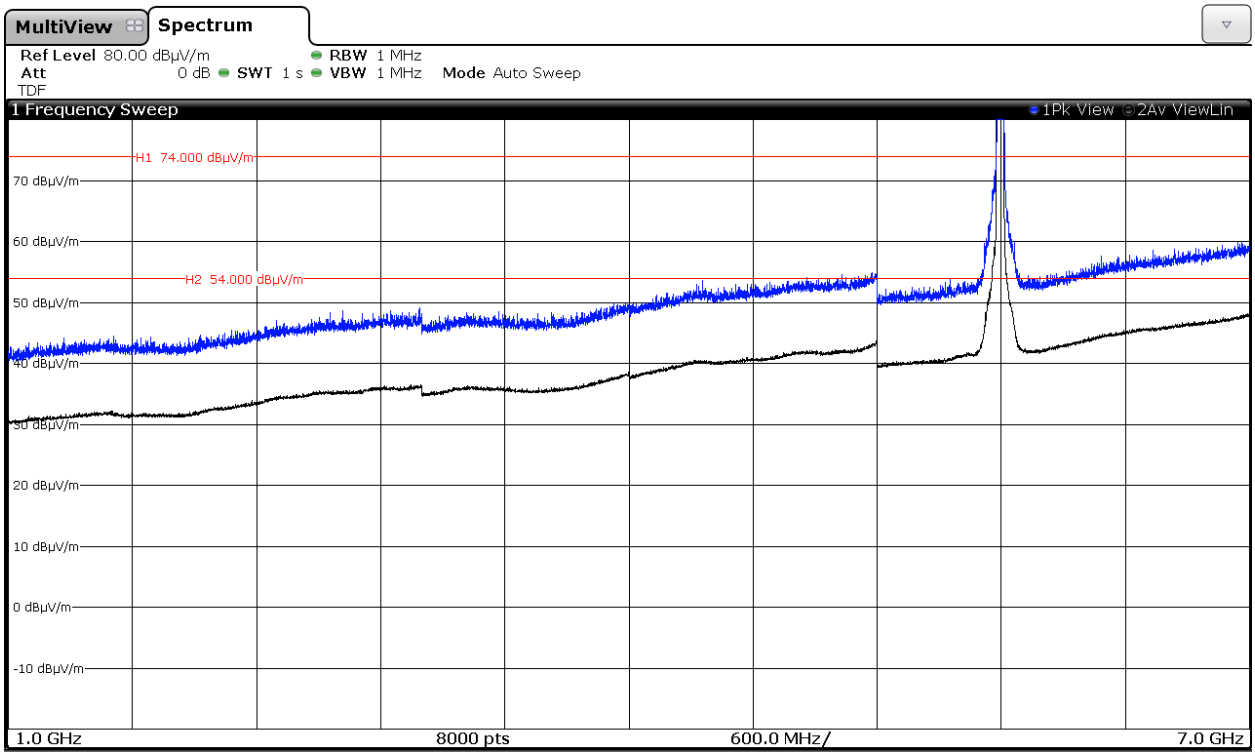
Note: The peak above the limit is the carrier frequency.

Highest Channel: 5795 MHz. Chain B



Note: The peak above the limit is the carrier frequency.

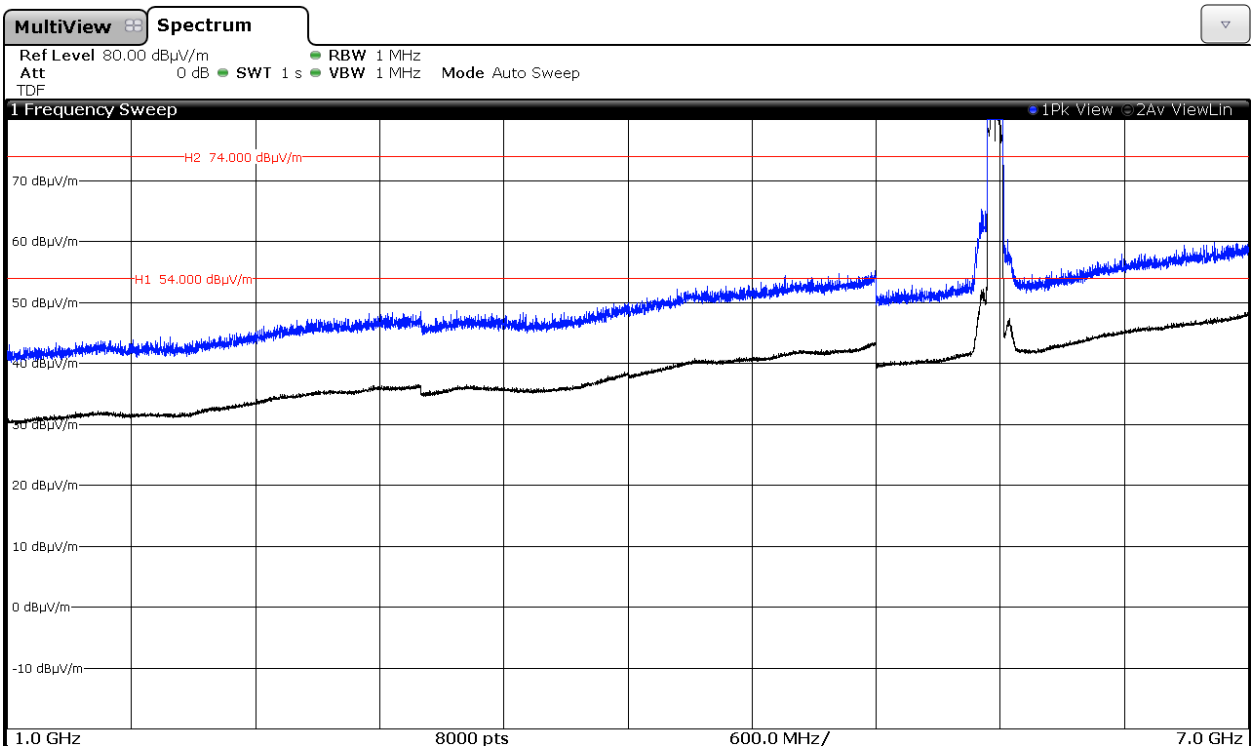
Highest Channel: 5795 MHz. Chain A+B



Note: The peak above the limit is the carrier frequency.

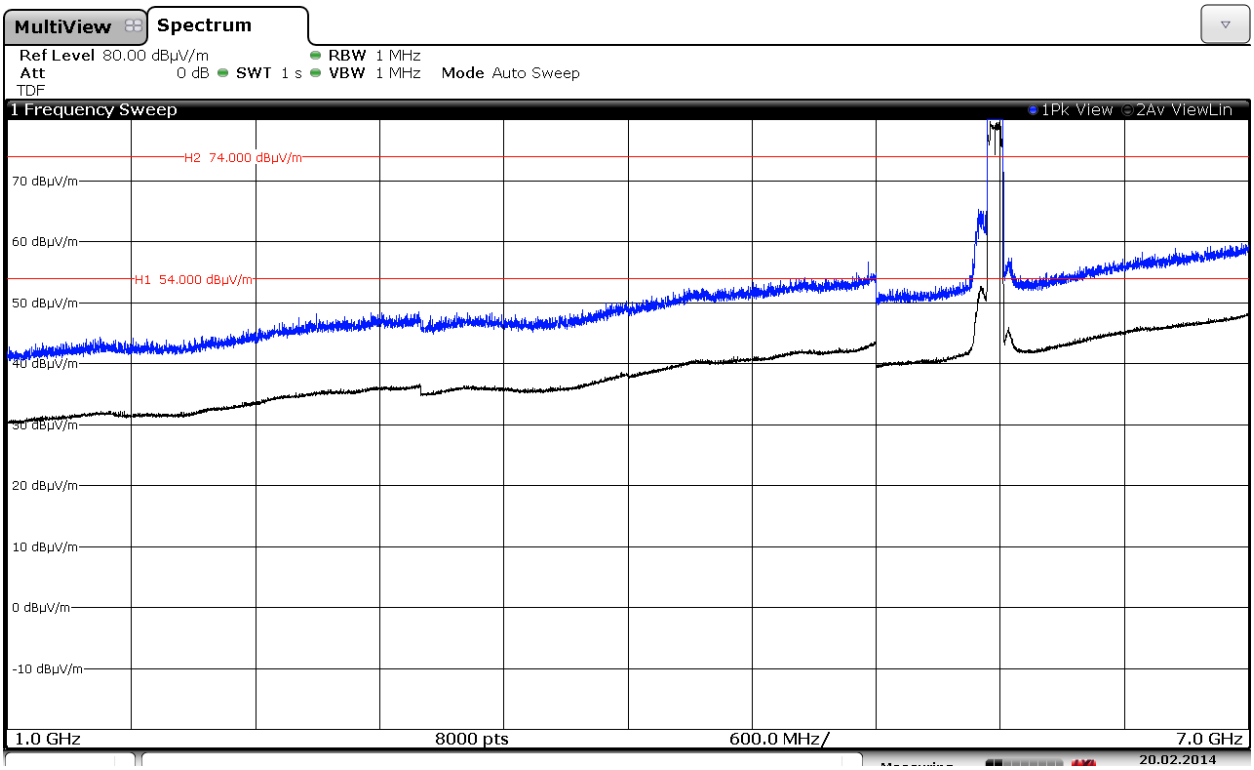
4. WiFi 5GHz 802.11 ac80 mode

Middle Channel: 5775 MHz. Chain A



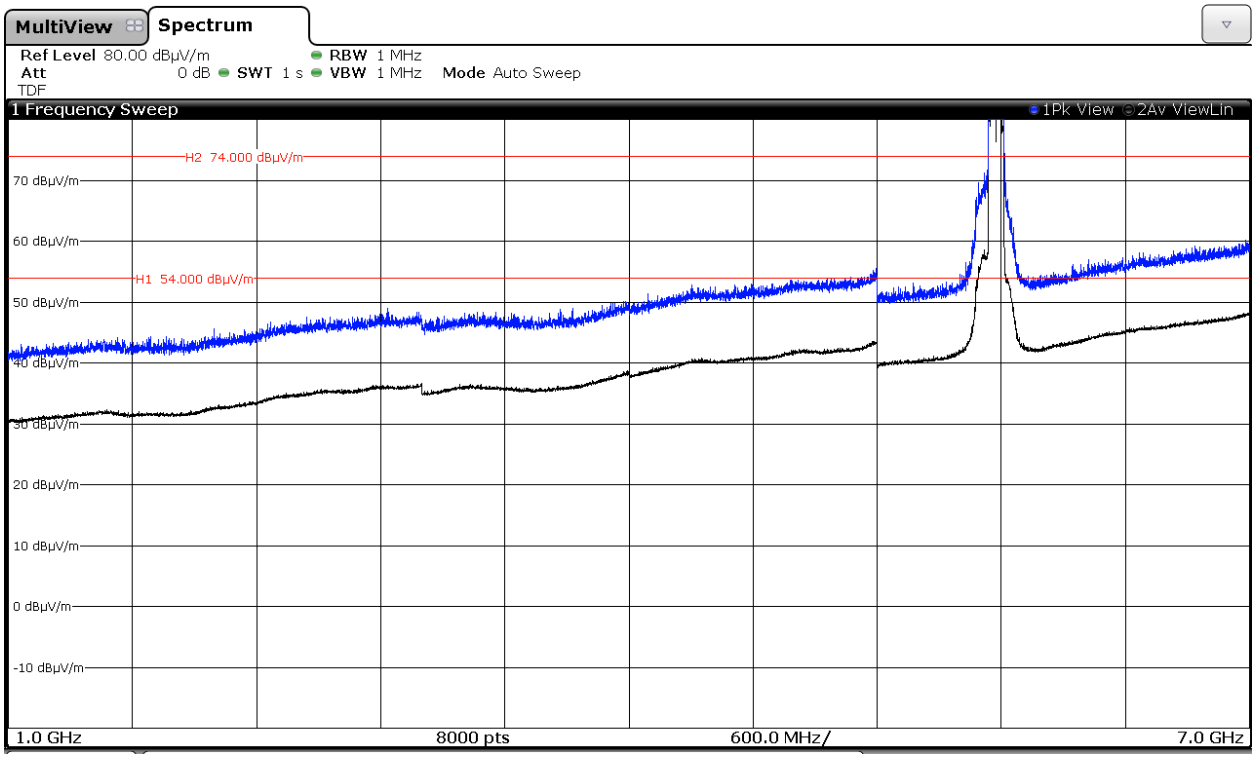
Note: The peak above the limit is the carrier frequency.

Middle Channel: 5775 MHz. Chain B



Note: The peak above the limit is the carrier frequency.

Middle Channel: 5775 MHz. Chain A+B

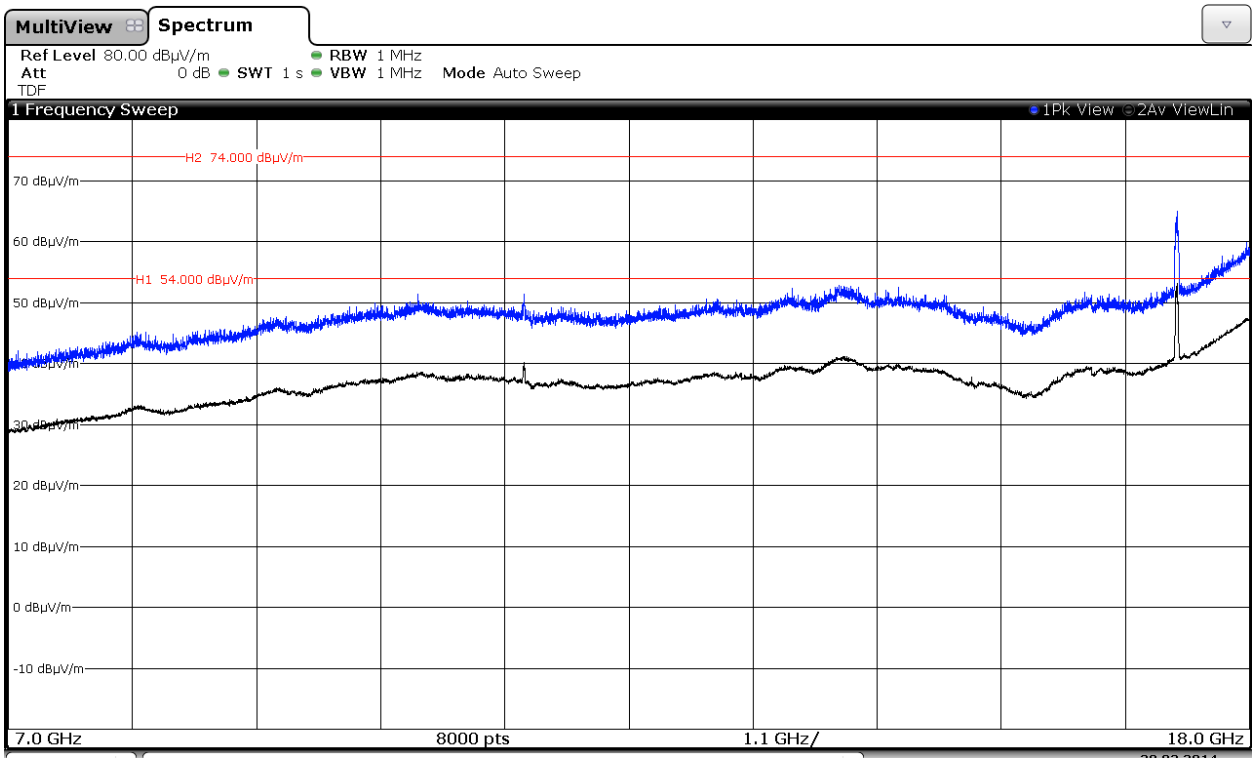


Note: The peak above the limit is the carrier frequency.

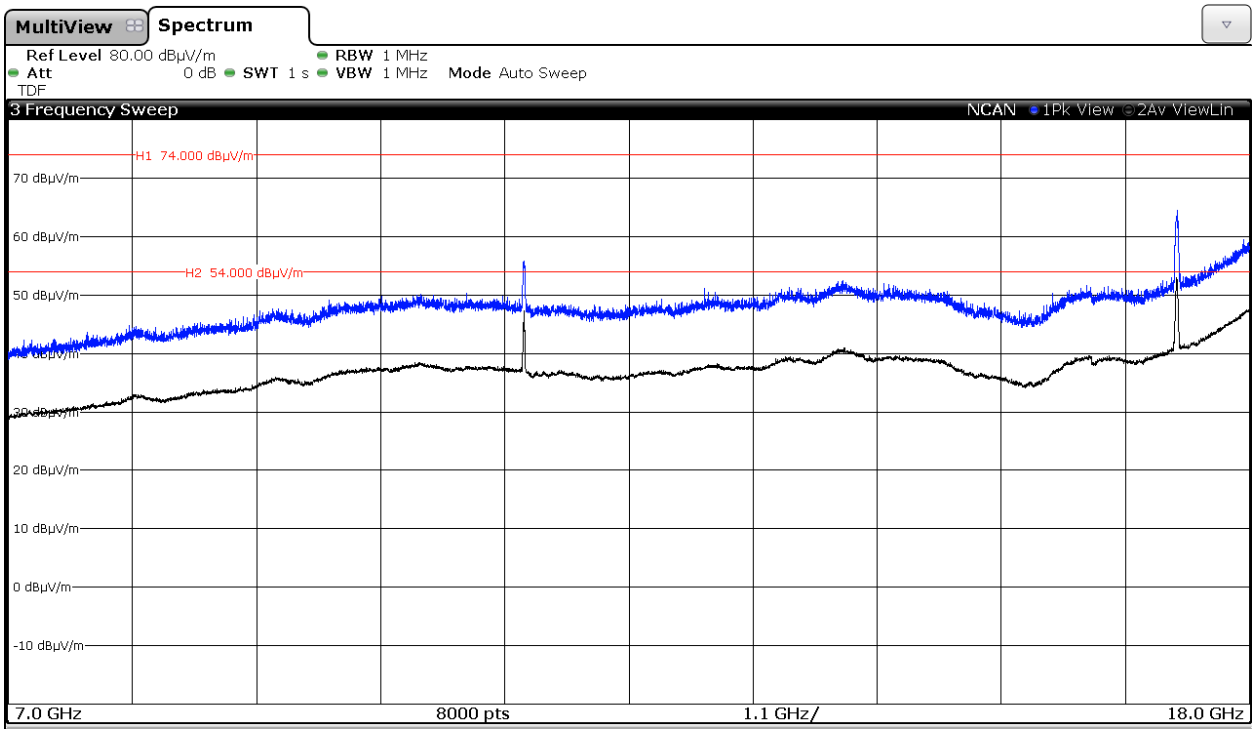
FREQUENCY RANGE 7 GHz to 18 GHz.

1. WiFi 5GHz 802.11 a mode

Middle Channel: 5785 MHz. Chain A

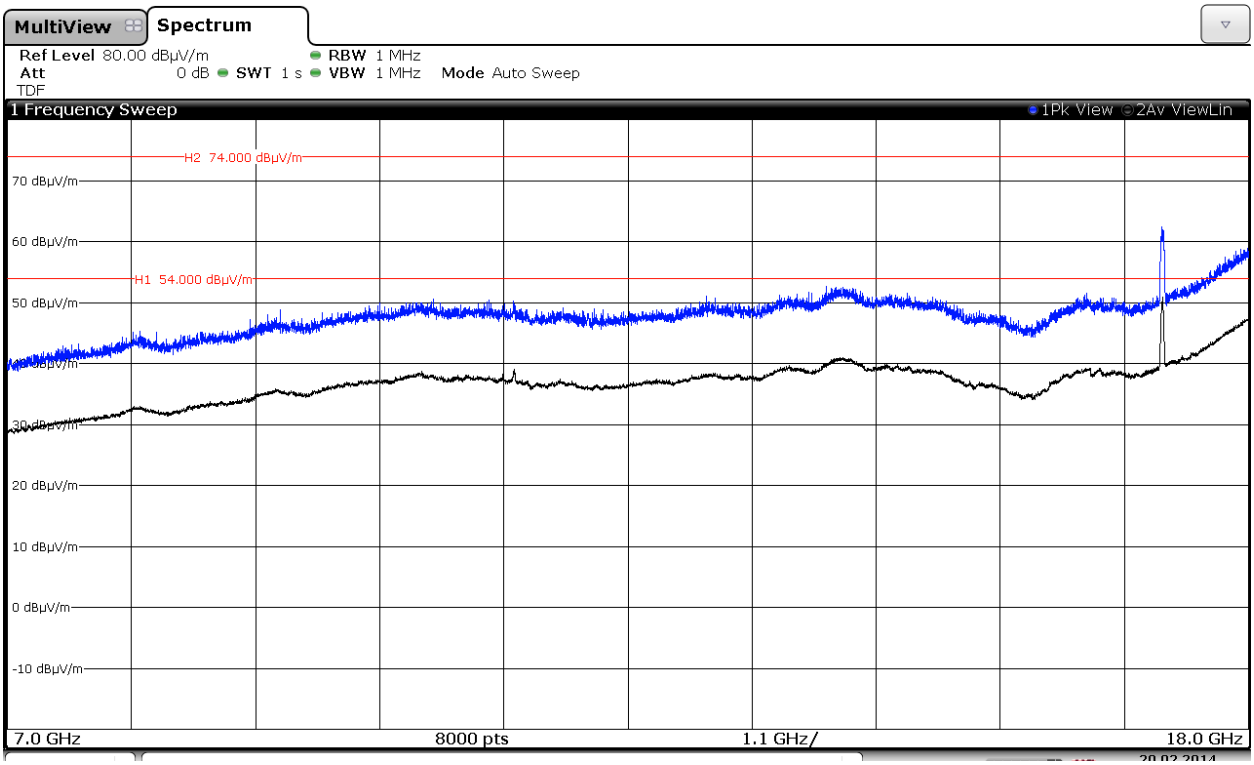


Middle Channel: 5785 MHz. Chain B

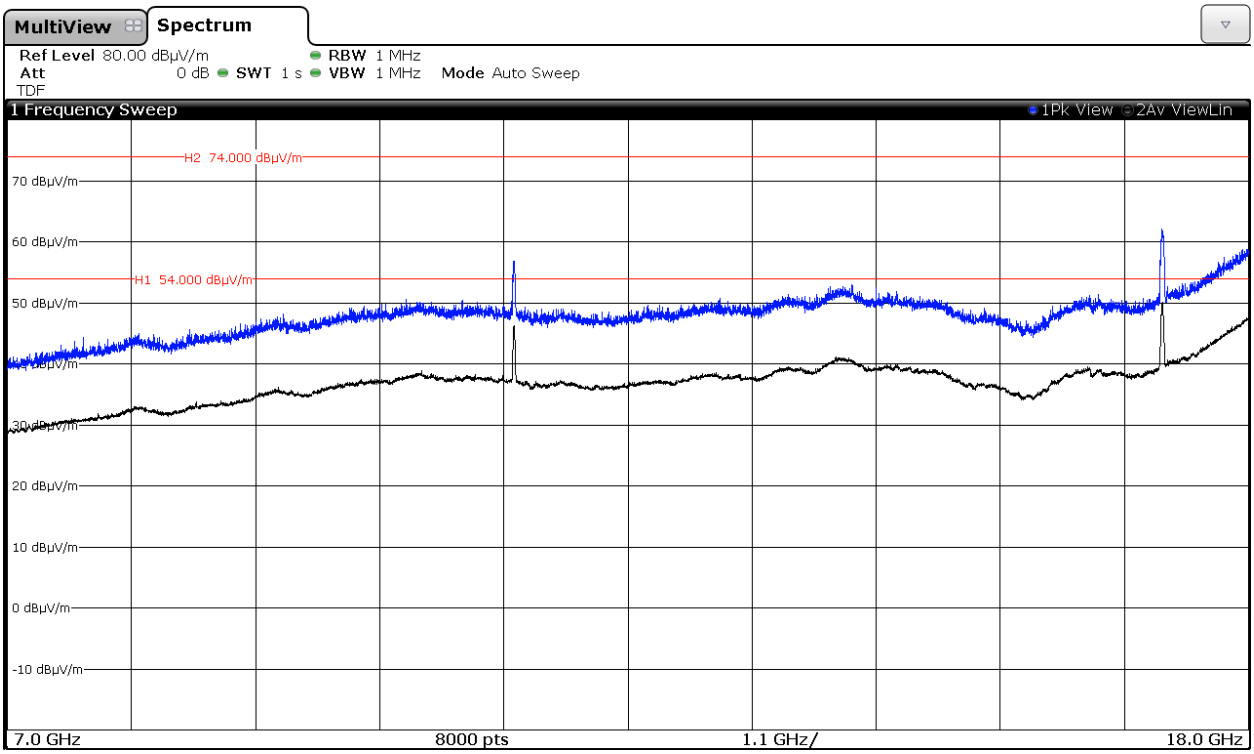


2. WiFi 5GHz 802.11 n20 mode

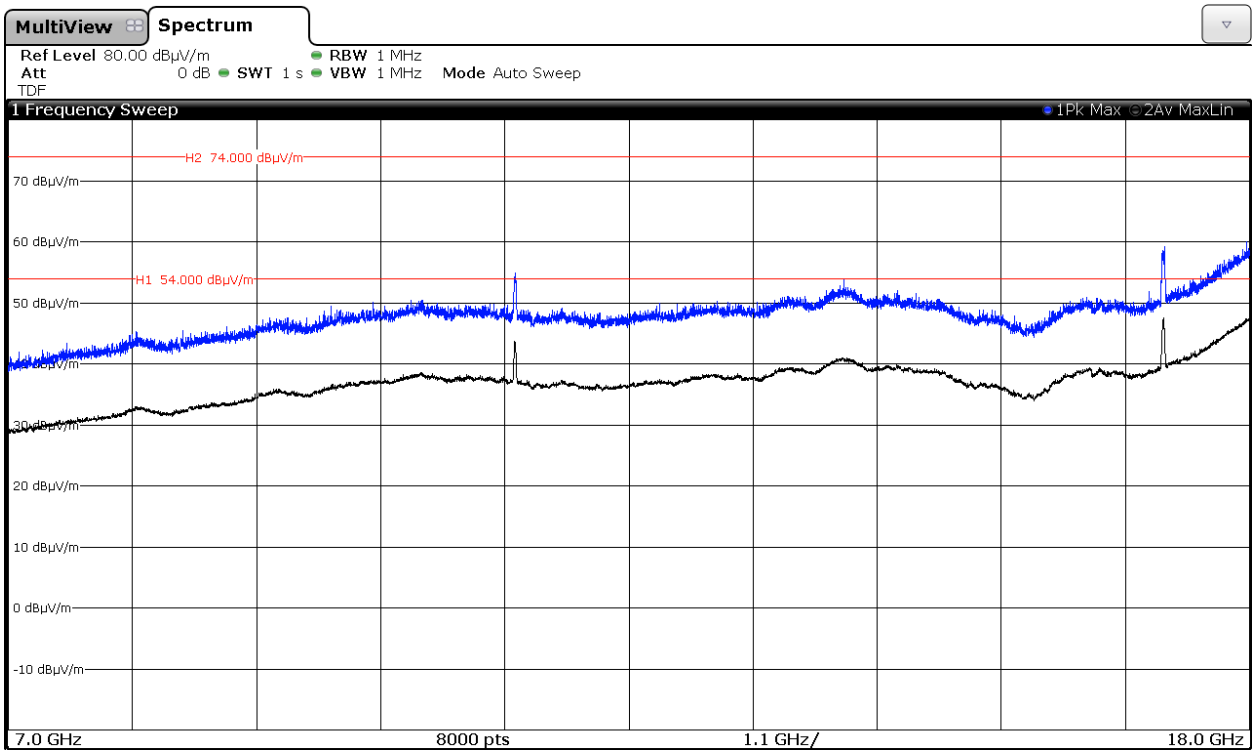
Lowest Channel: 5745 MHz. Chain A



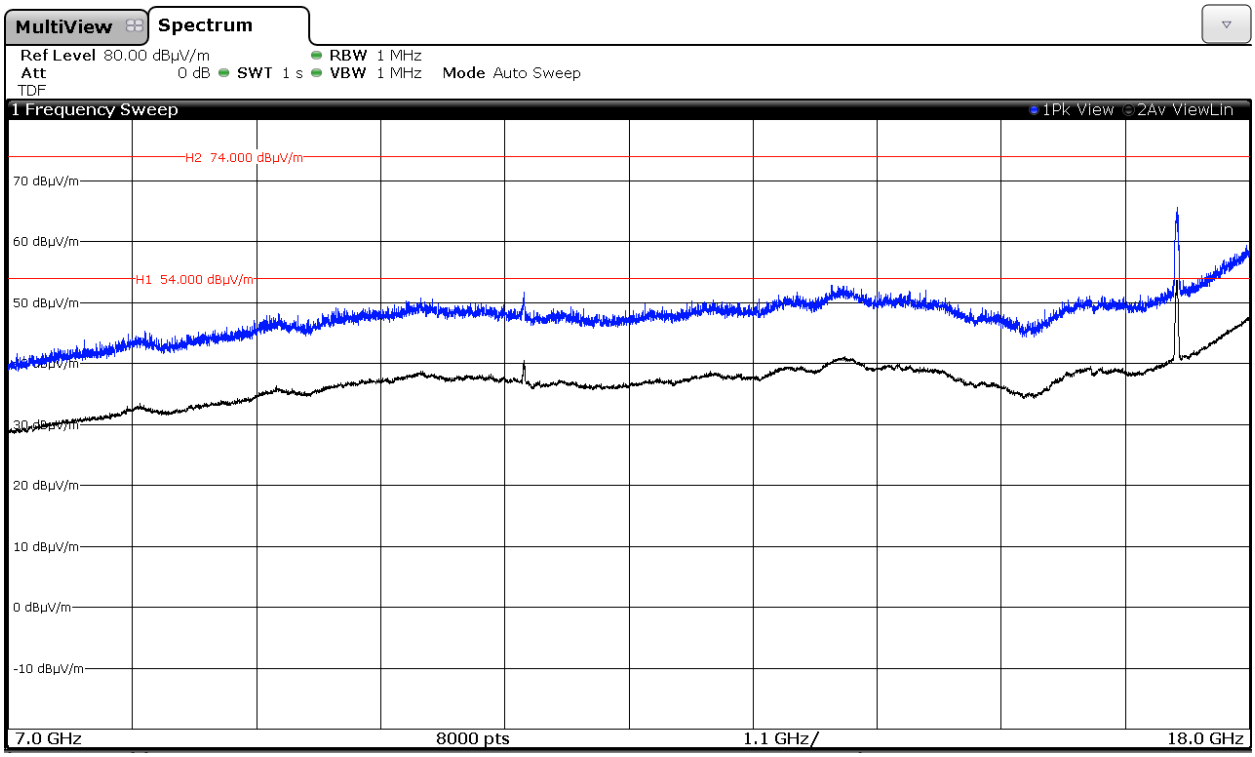
Lowest Channel: 5745 MHz. Chain B



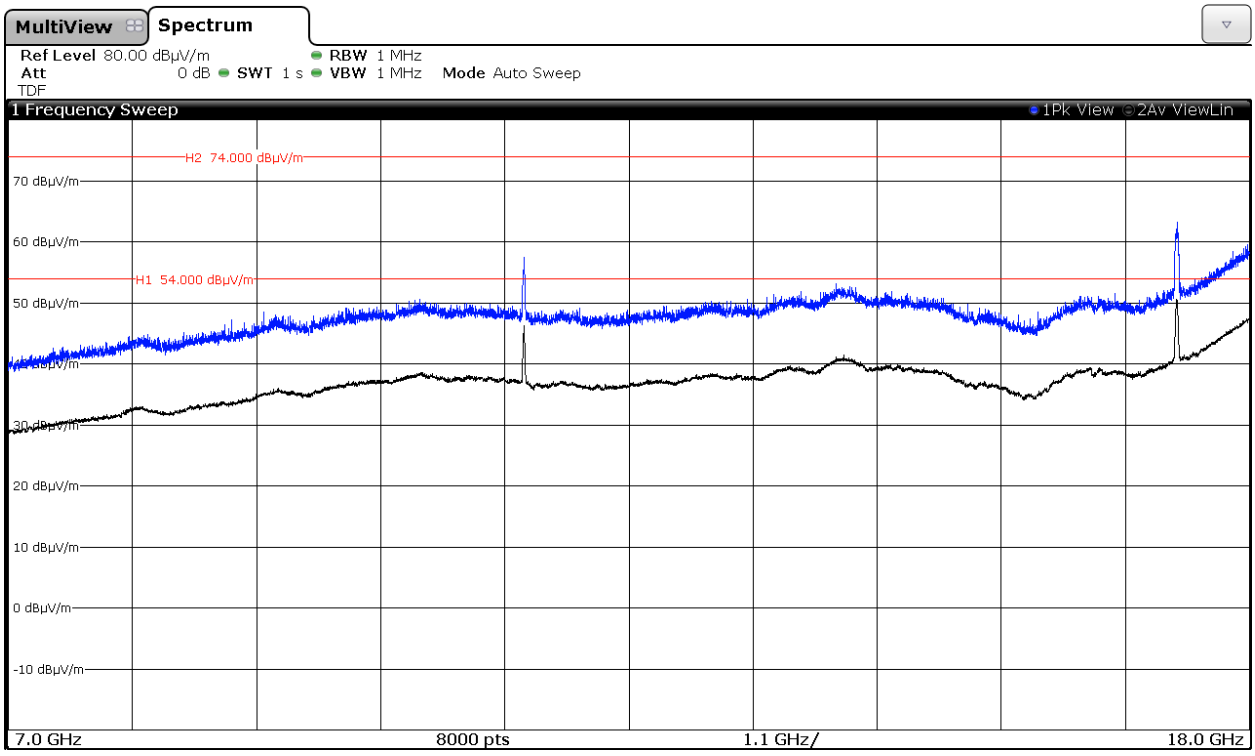
Lowest Channel: 5745 MHz. Chain A+B



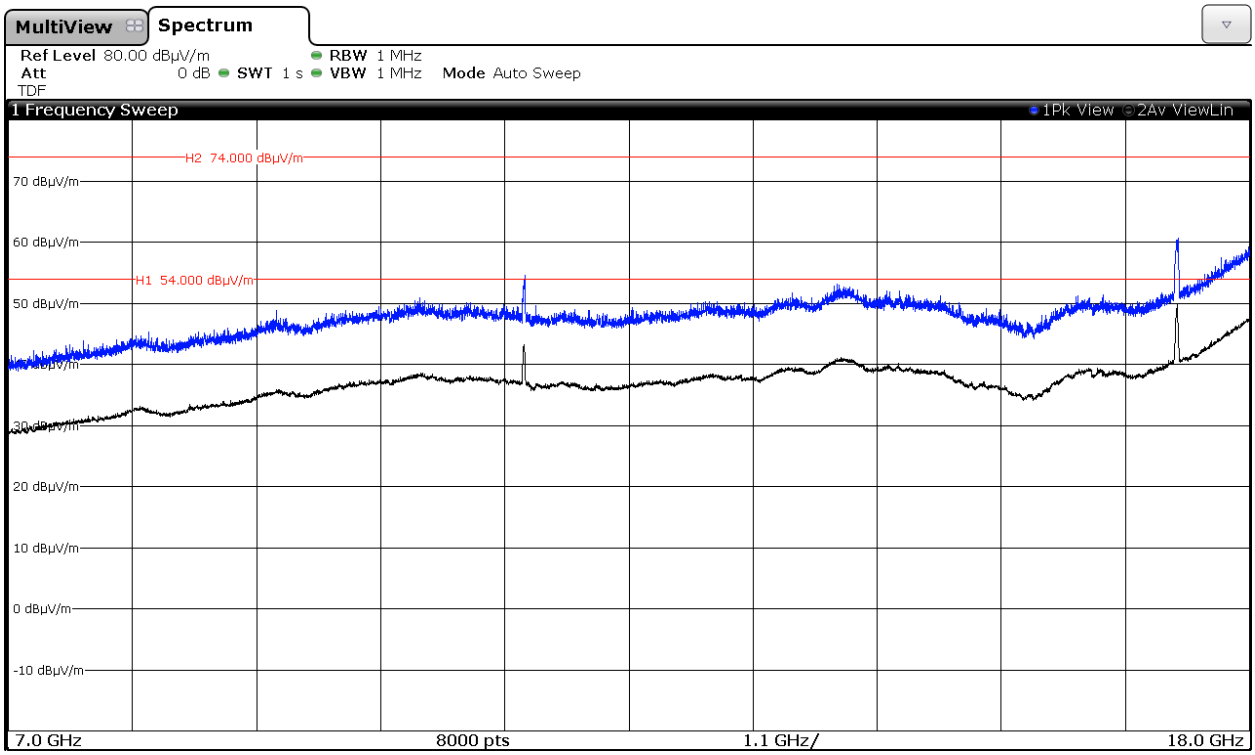
Middle Channel: 5785 MHz. Chain A



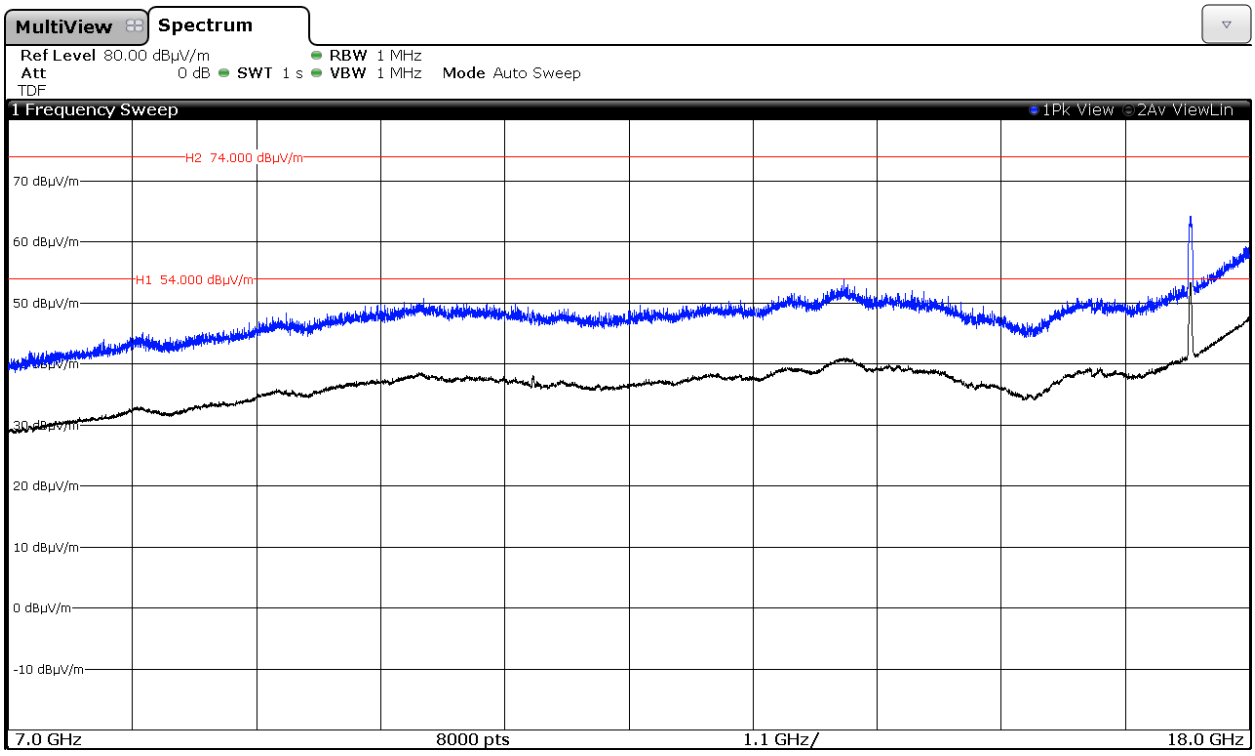
Middle Channel: 5785 MHz. Chain B



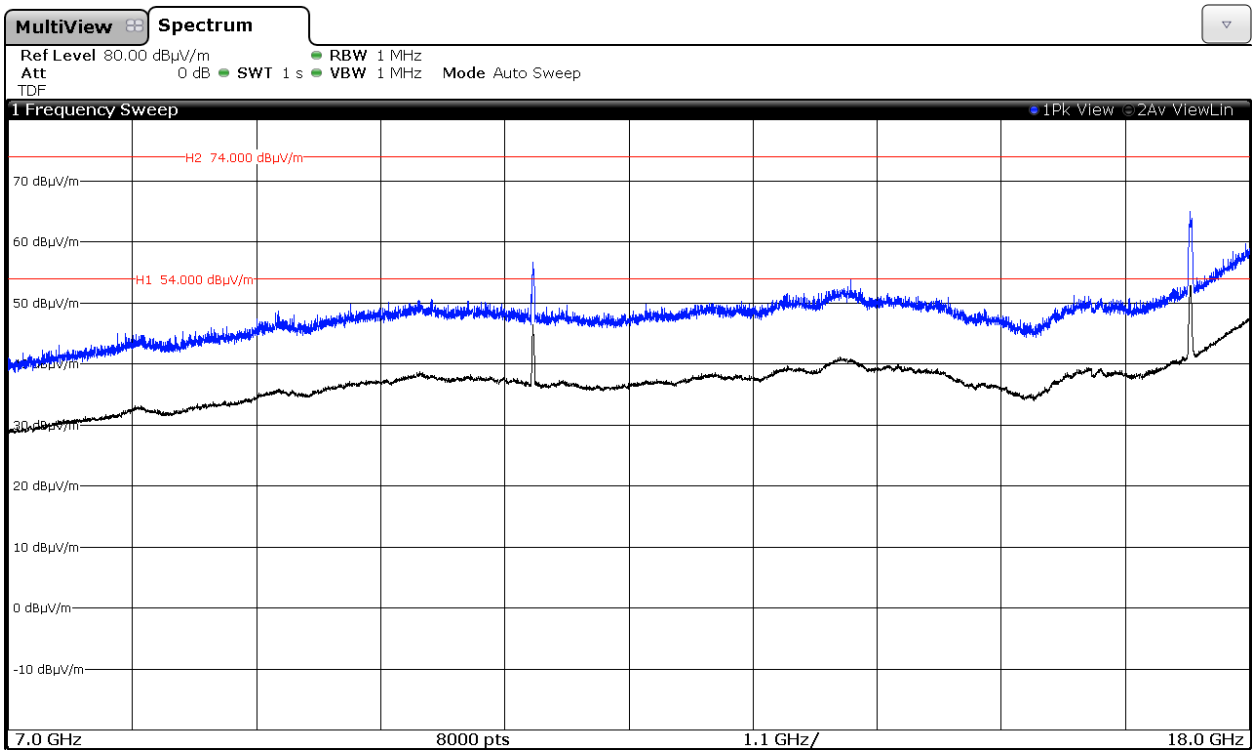
Middle Channel: 5785 MHz. Chain A+B



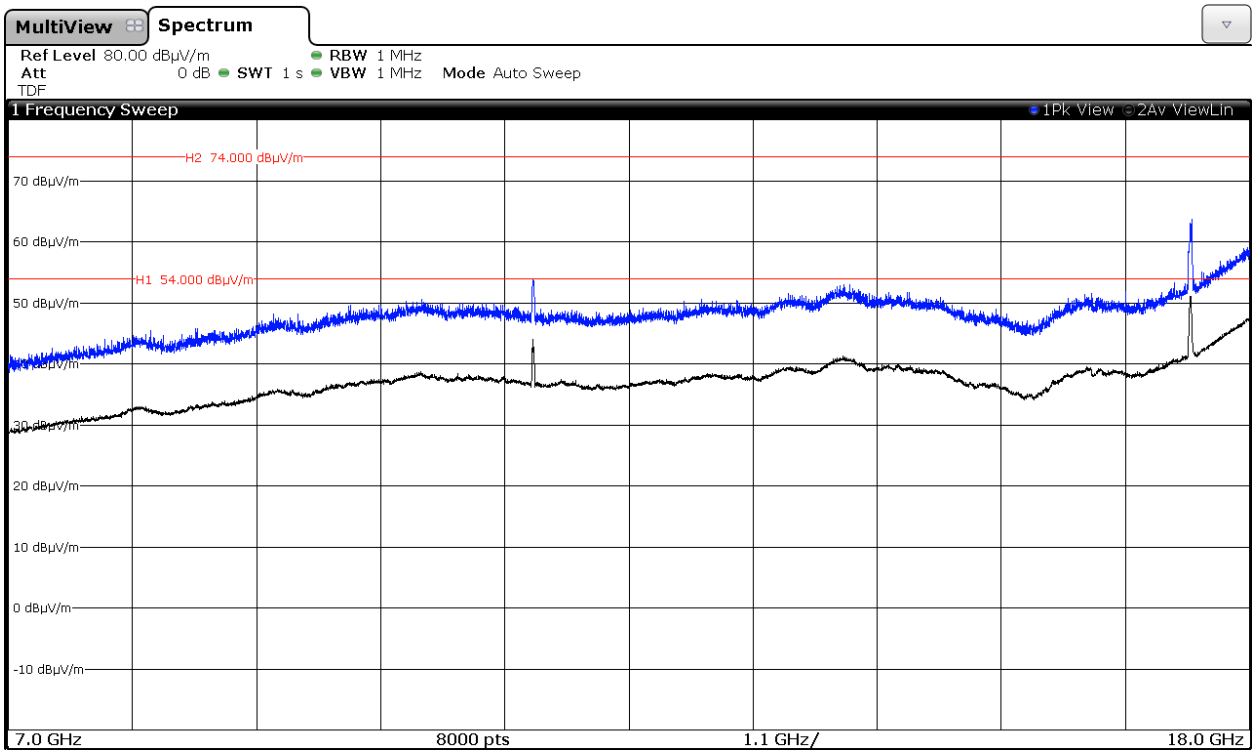
Highest Channel: 5825 MHz. Chain A



Highest Channel: 5825 MHz. Chain B

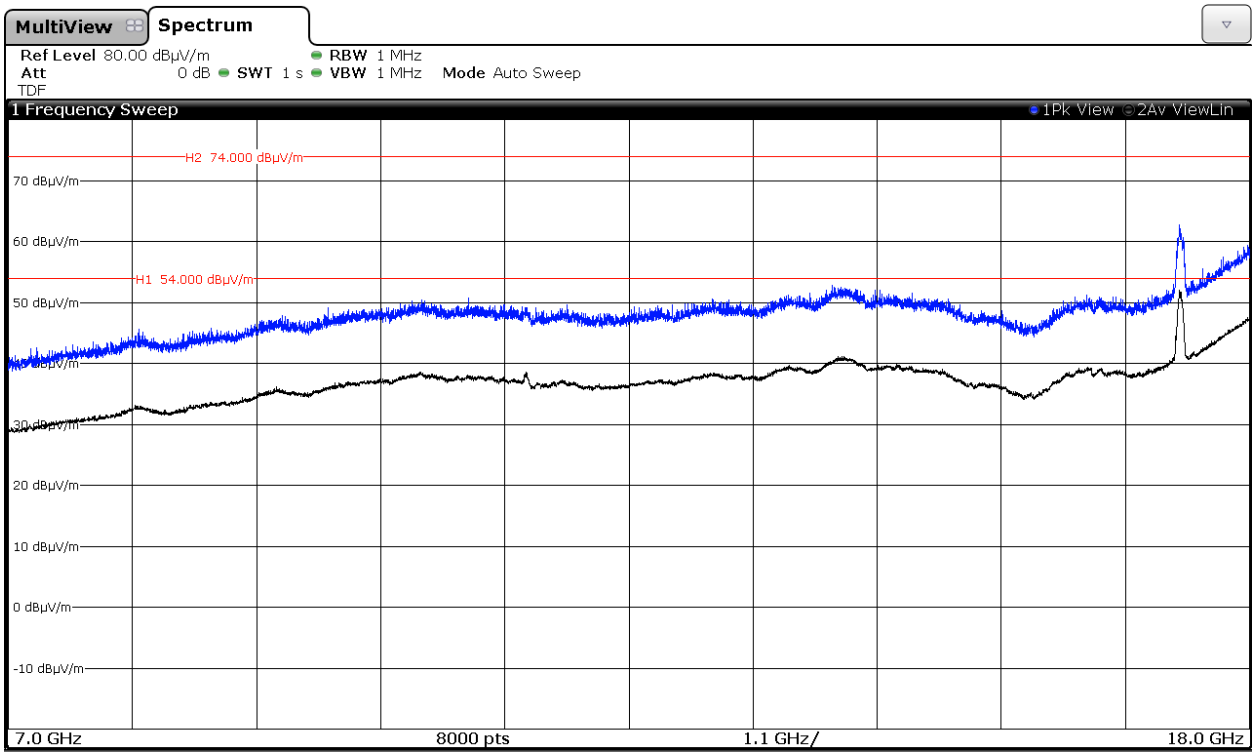


Highest Channel: 5825 MHz. Chain A+B

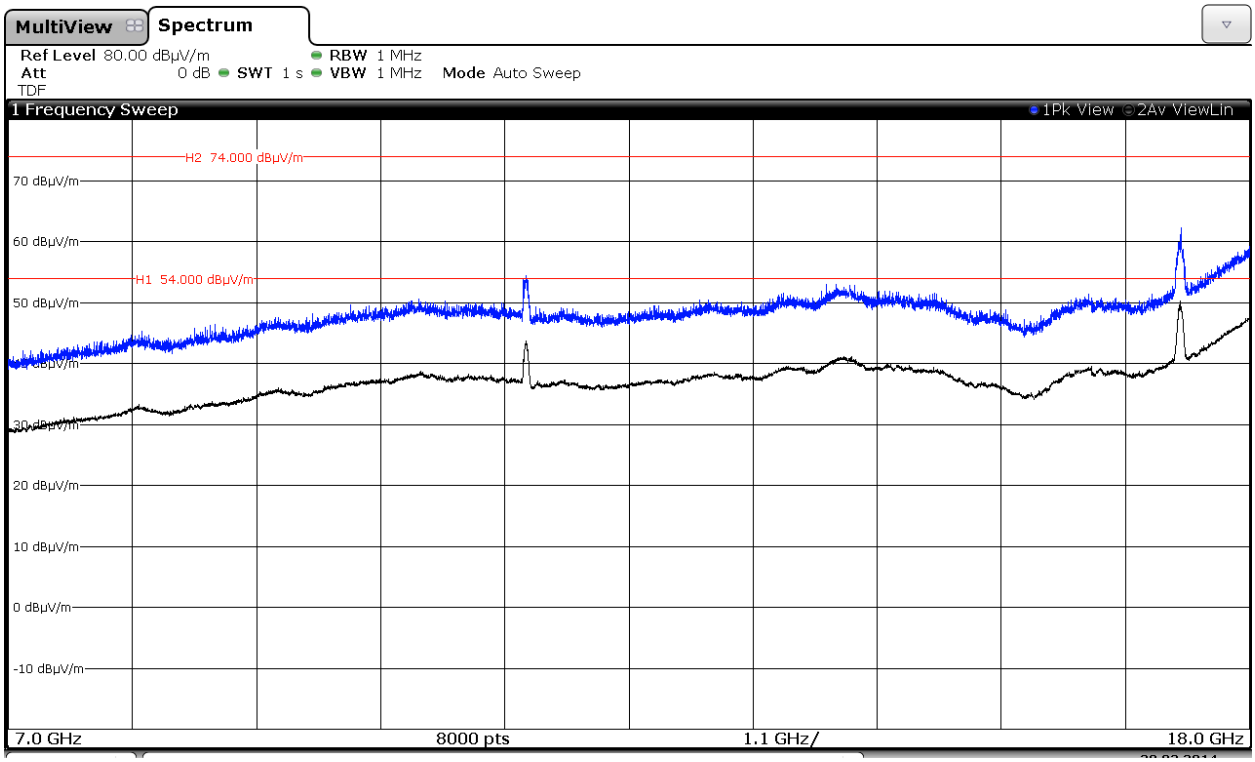


3. WiFi 5GHz 802.11 n40 mode

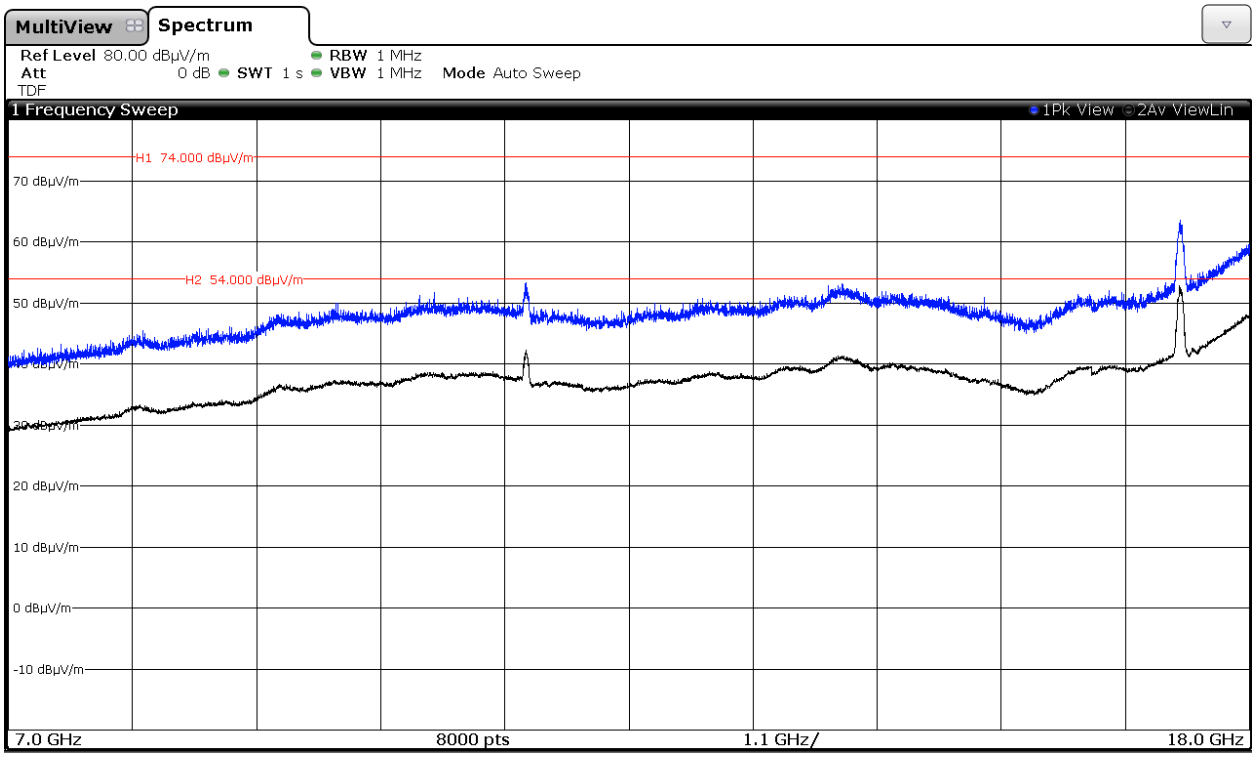
Highest Channel: 5795 MHz. Chain A



Highest Channel: 5795 MHz. Chain B

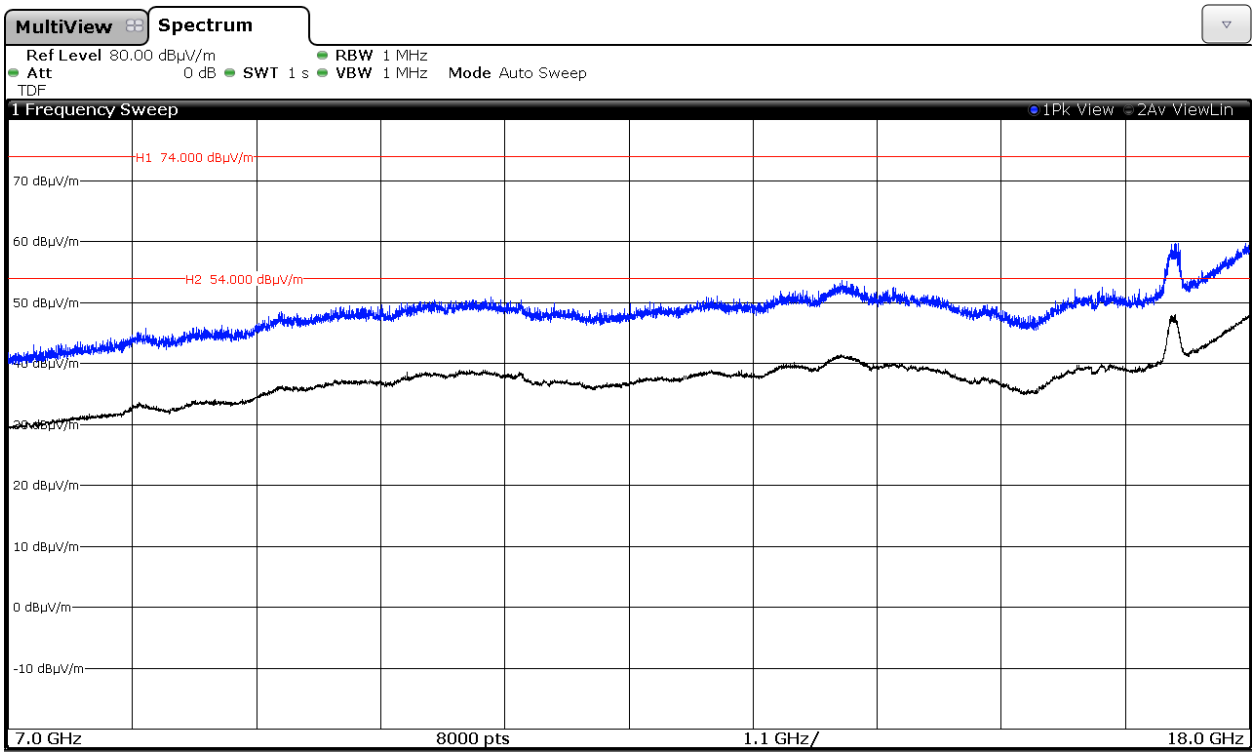


Highest Channel: 5795 MHz. Chain A+B

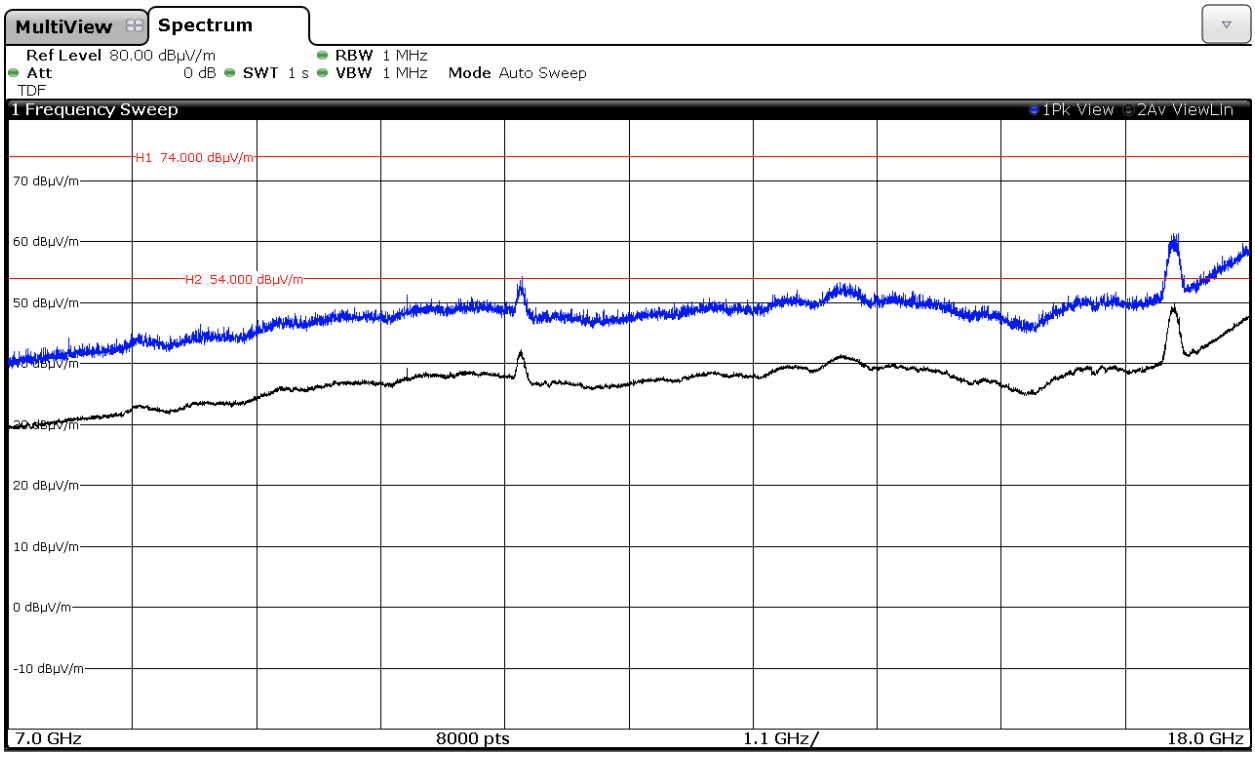


4. WiFi 5GHz 802.11 ac80 mode

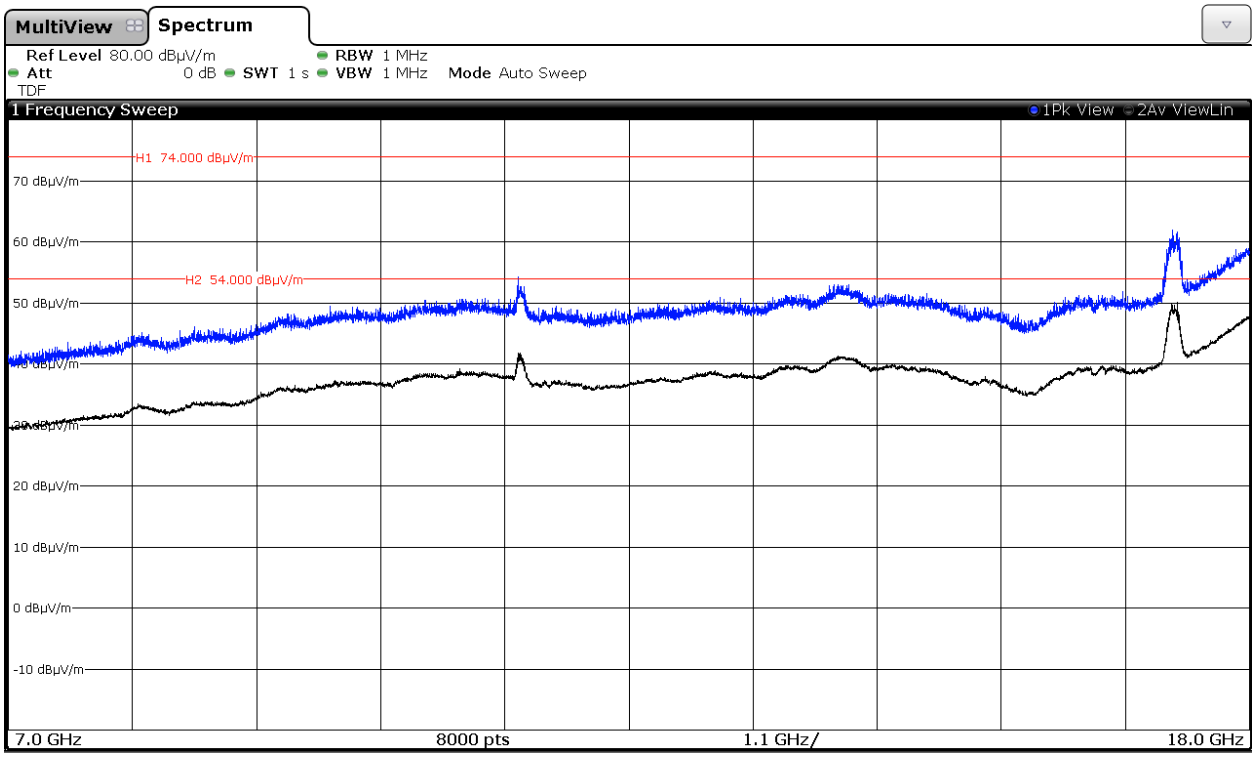
Middle Channel: 5775 MHz. Chain A.



Middle Channel: 5775 MHz. Chain B.



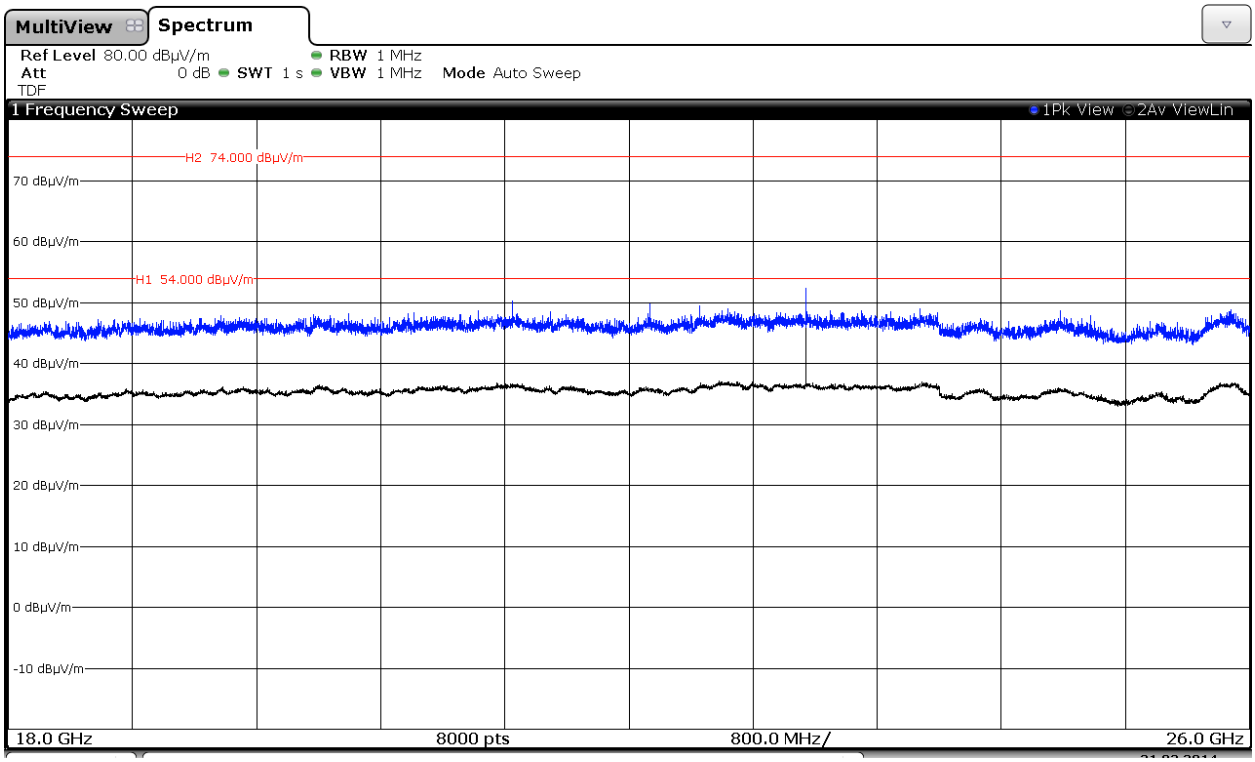
Middle Channel: 5775 MHz. Chain A+B.



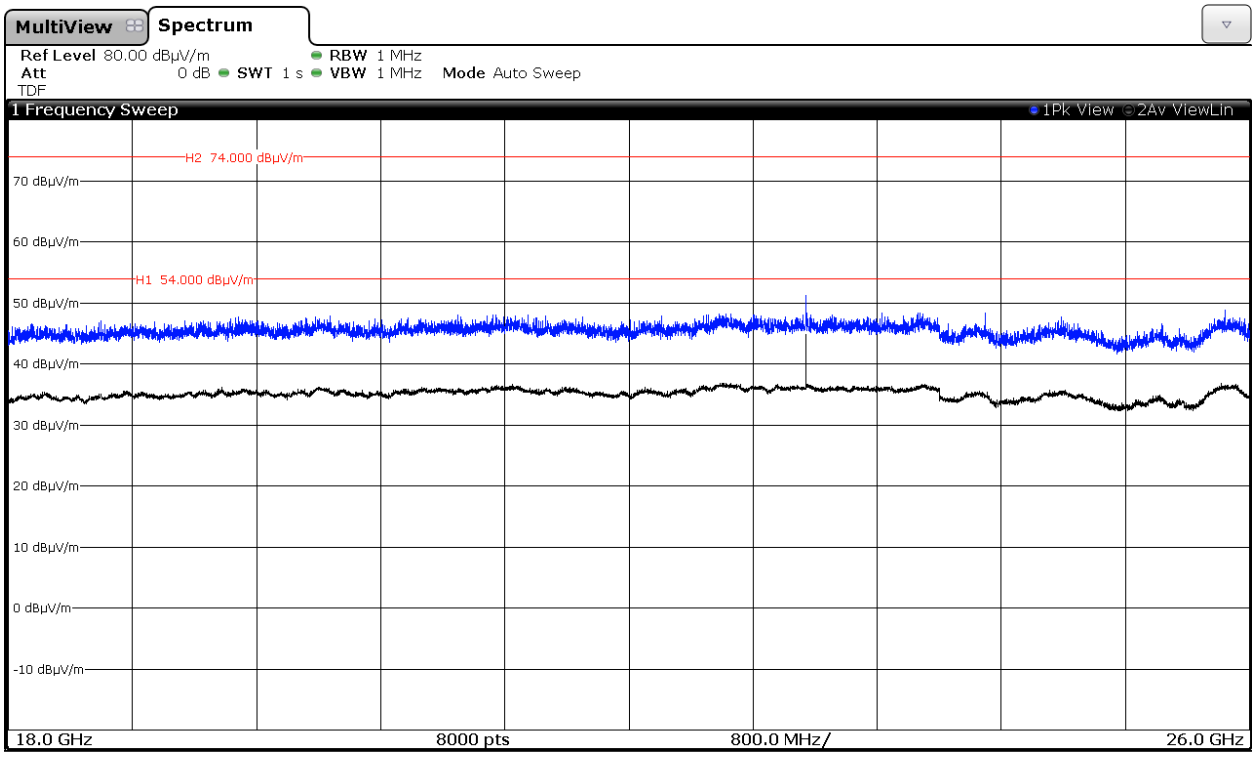
FREQUENCY RANGE 18 GHz to 26 GHz.

1. WiFi 5GHz 802.11 a mode

Middle Channel: 5785 MHz. Chain A

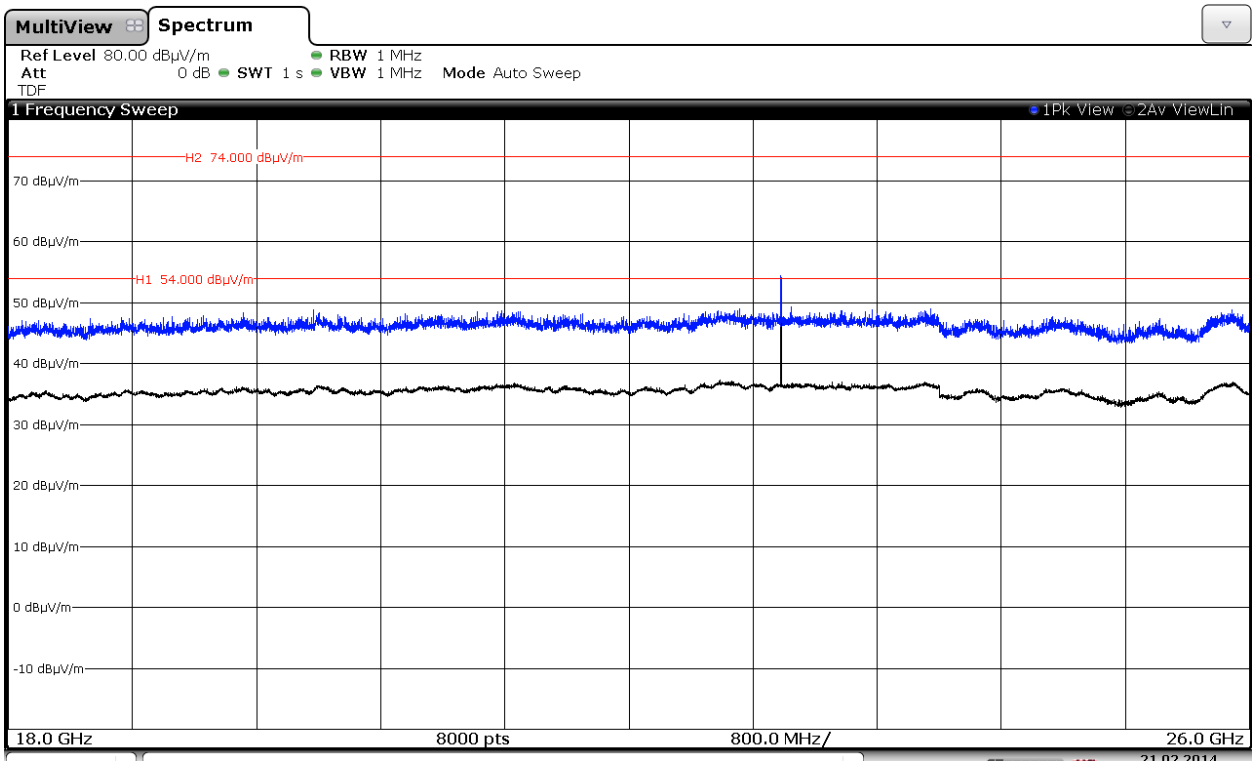


Middle Channel: 5785 MHz. Chain B

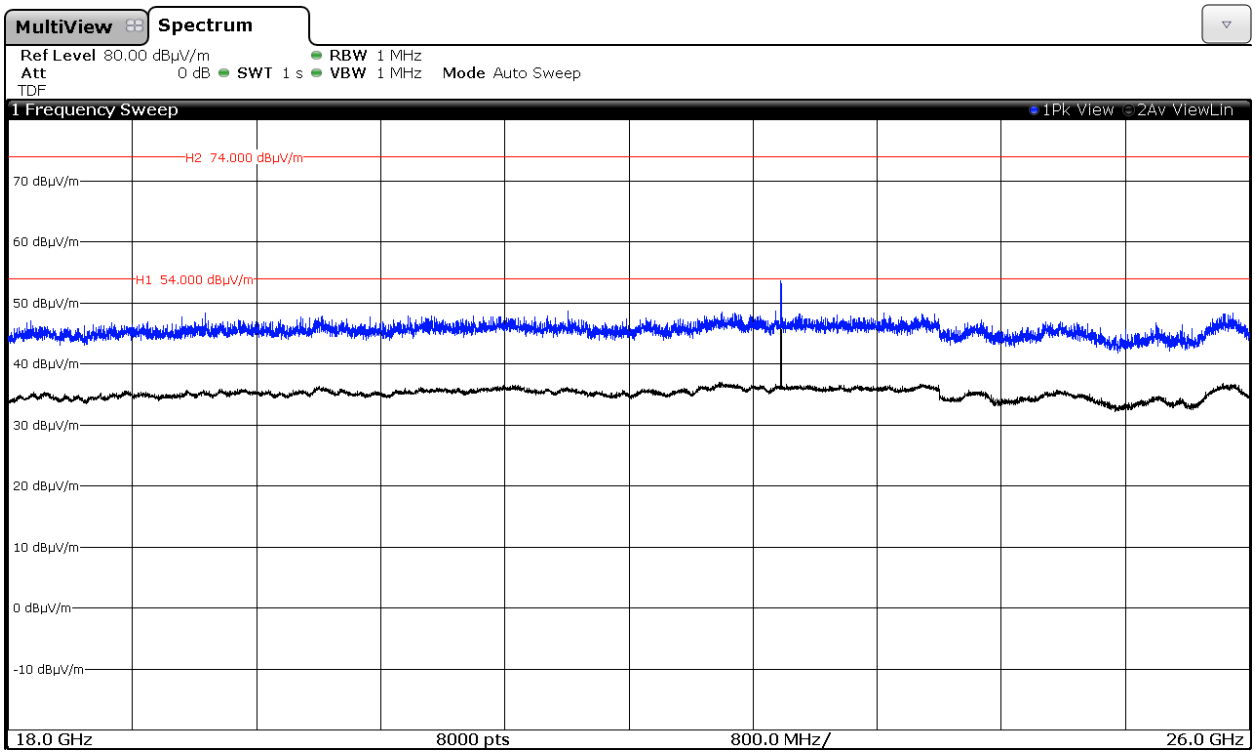


2. WiFi 5GHz 802.11 n20 mode

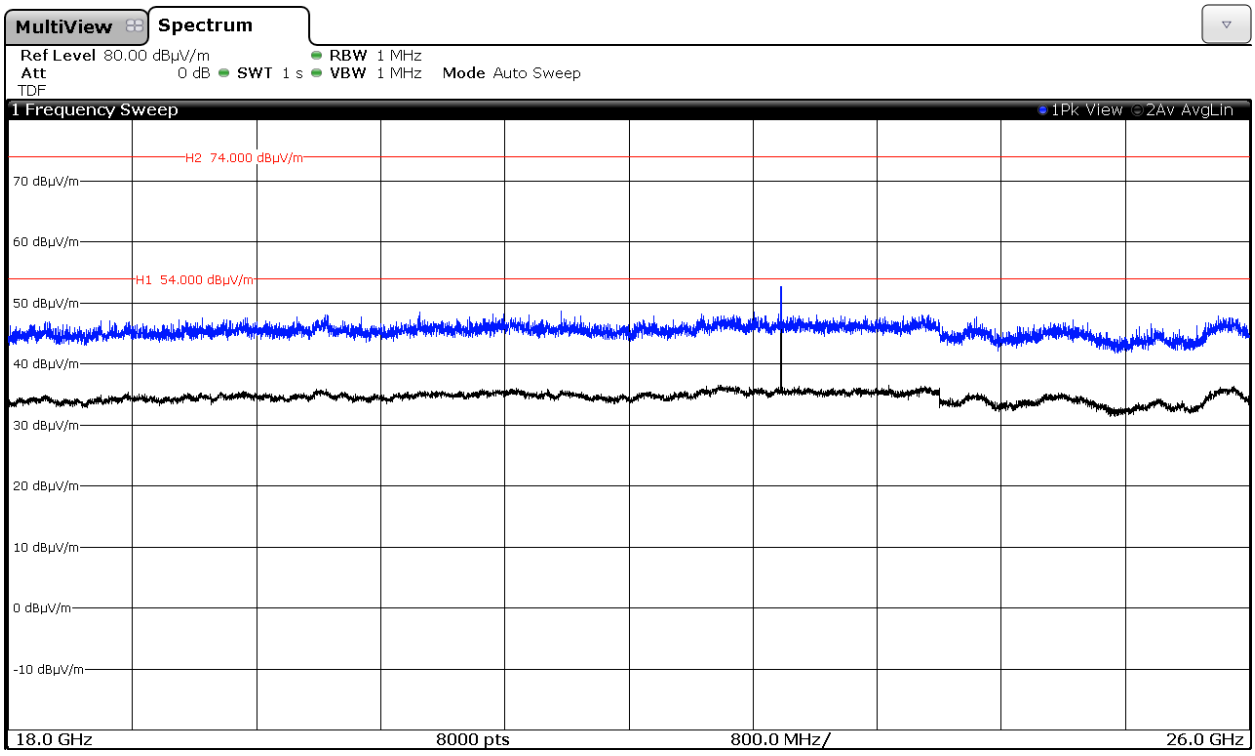
Lowest Channel: 5745 MHz. Chain A



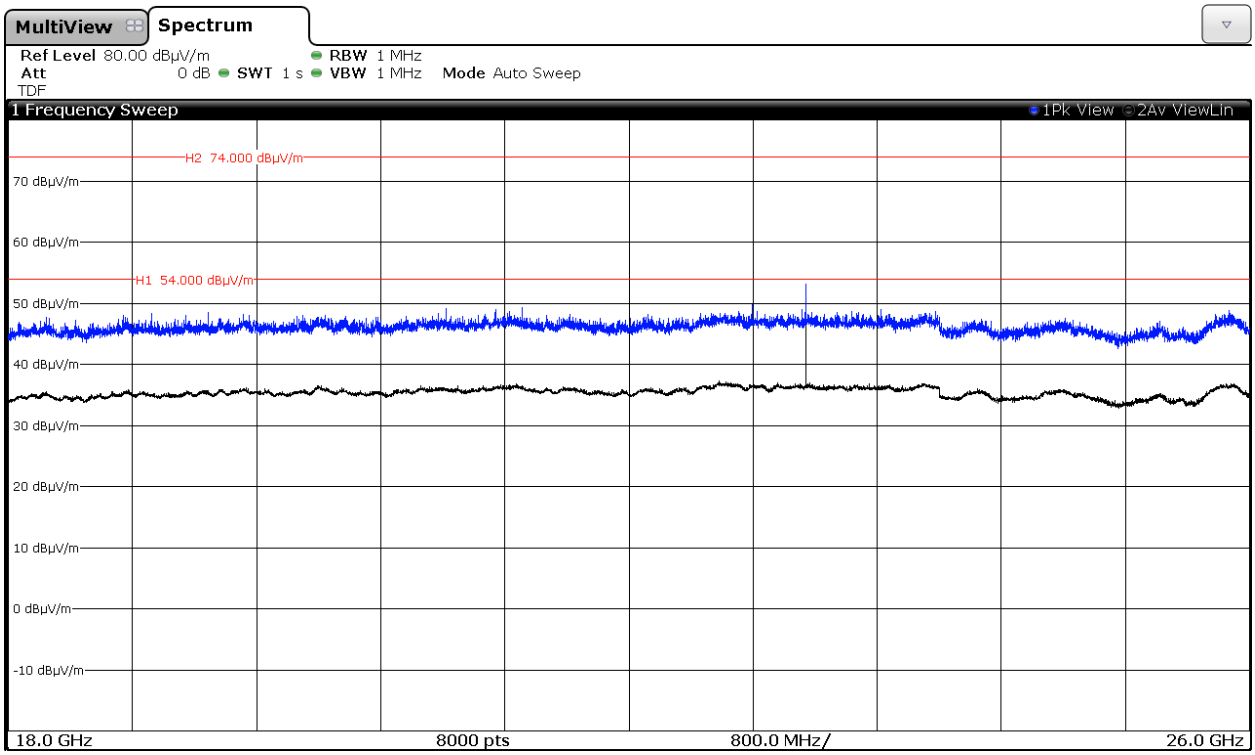
Lowest Channel: 5745 MHz. Chain B



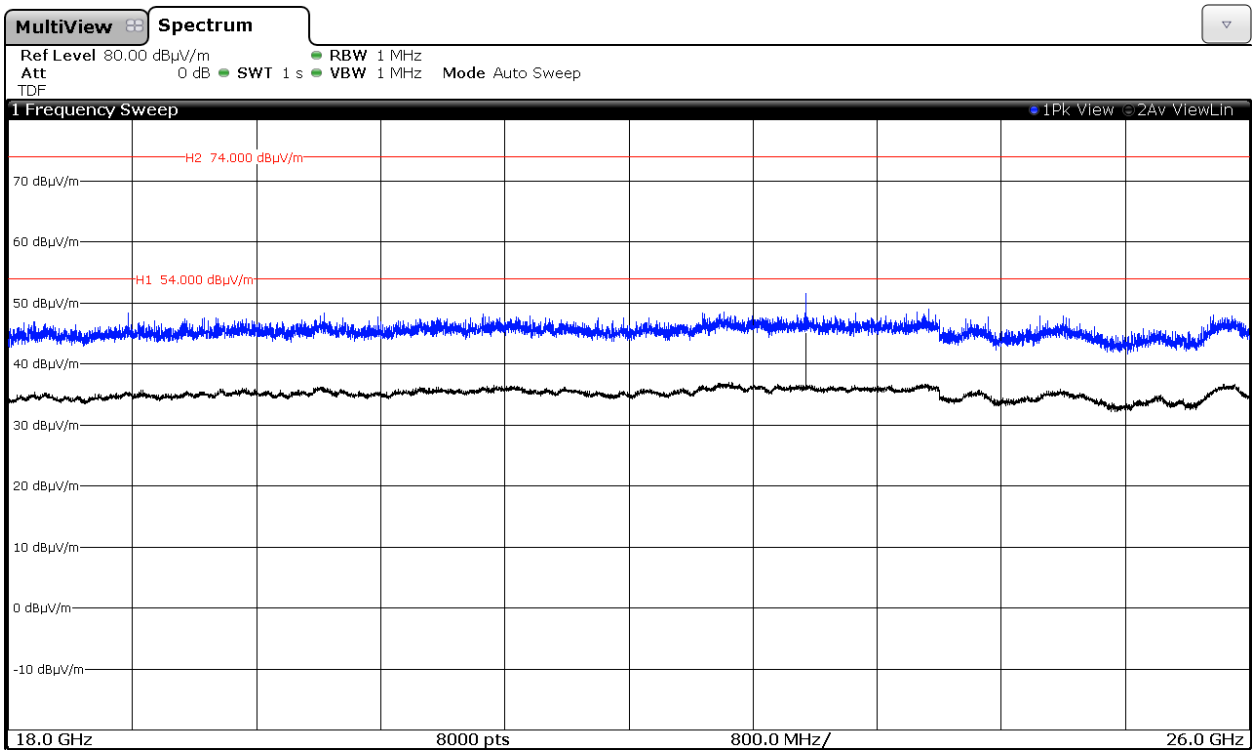
Lowest Channel: 5745 MHz. Chain A+B



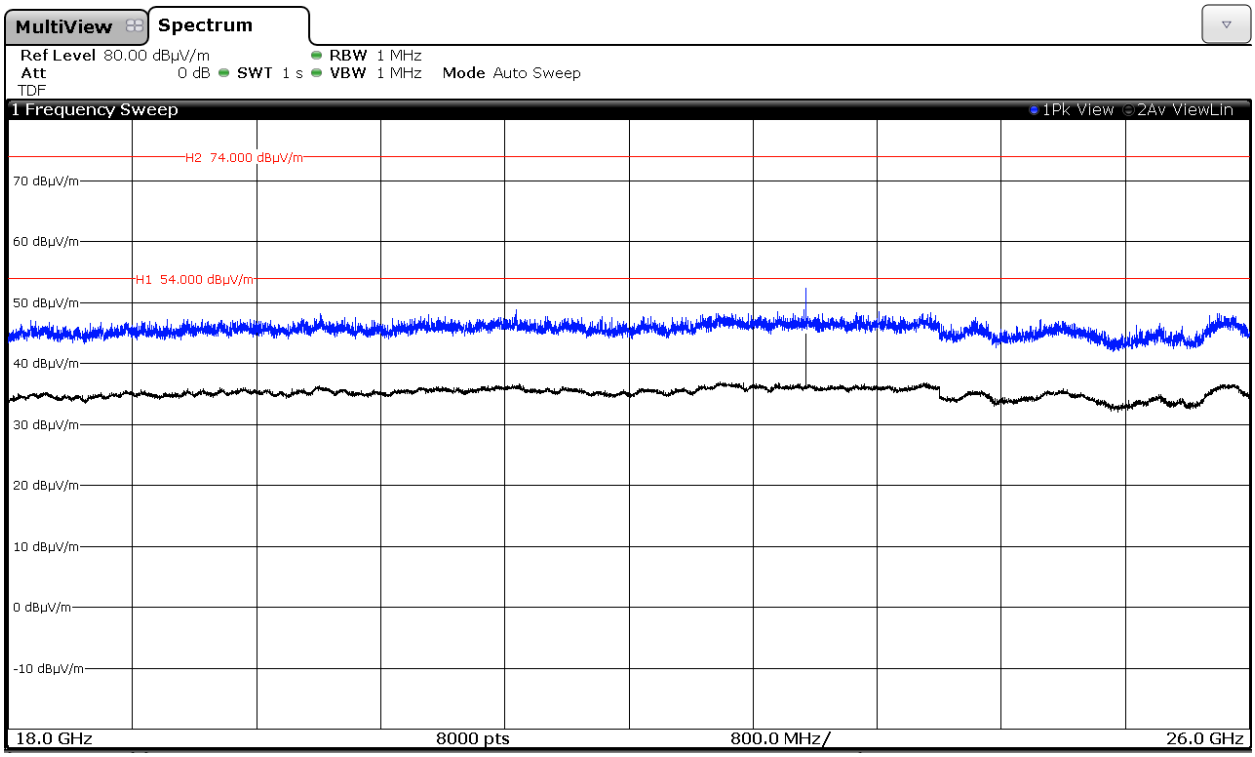
Middle Channel: 5785 MHz. Chain A



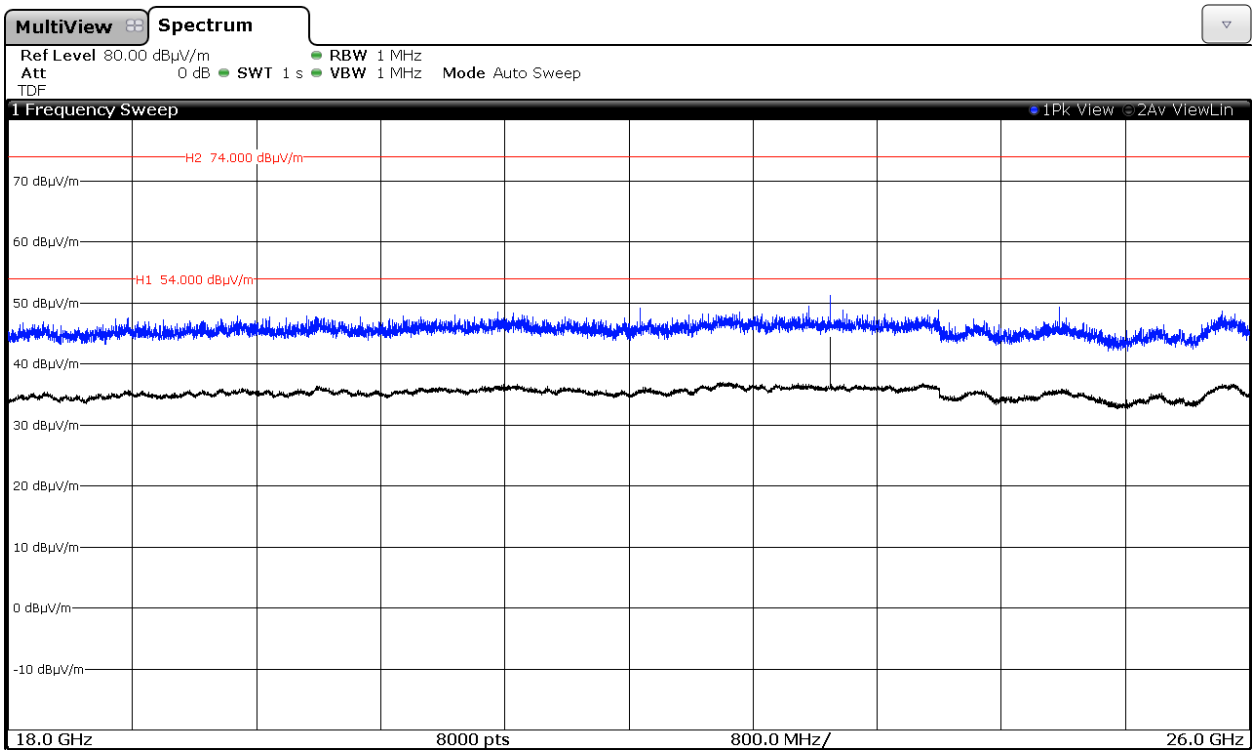
Middle Channel: 5785 MHz. Chain B



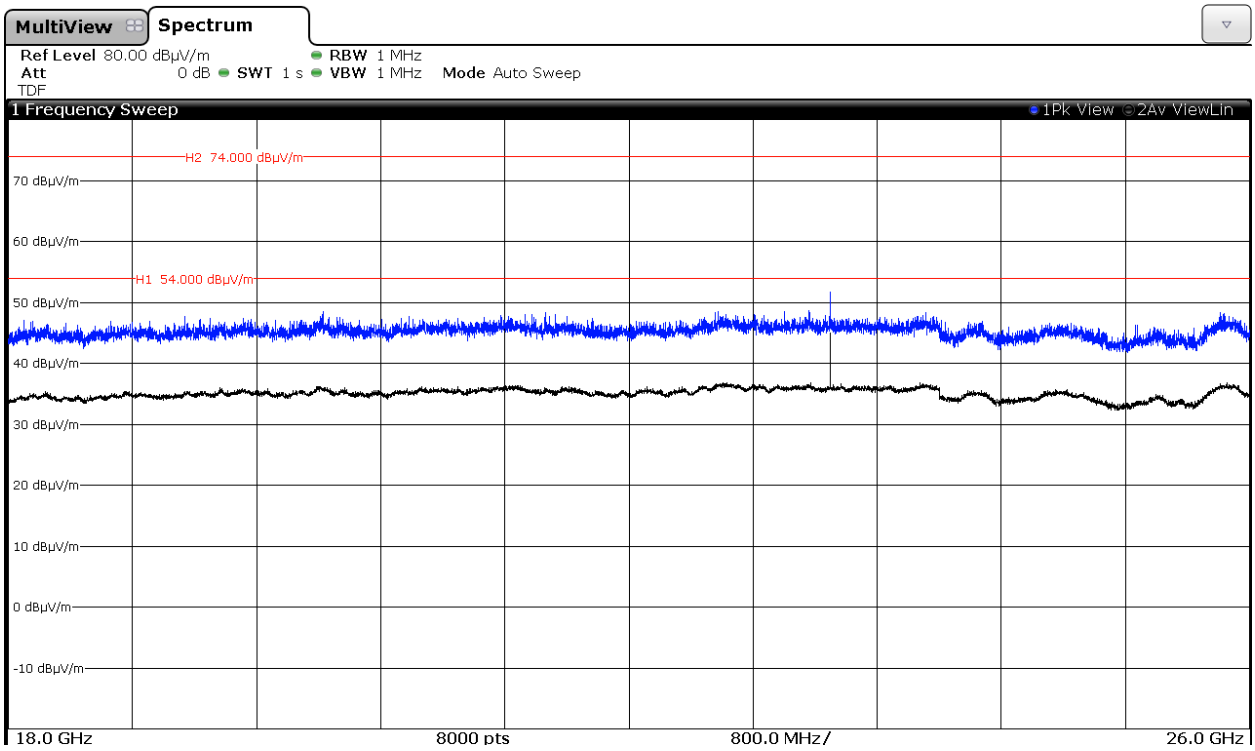
Middle Channel: 5785 MHz. Chain A+B



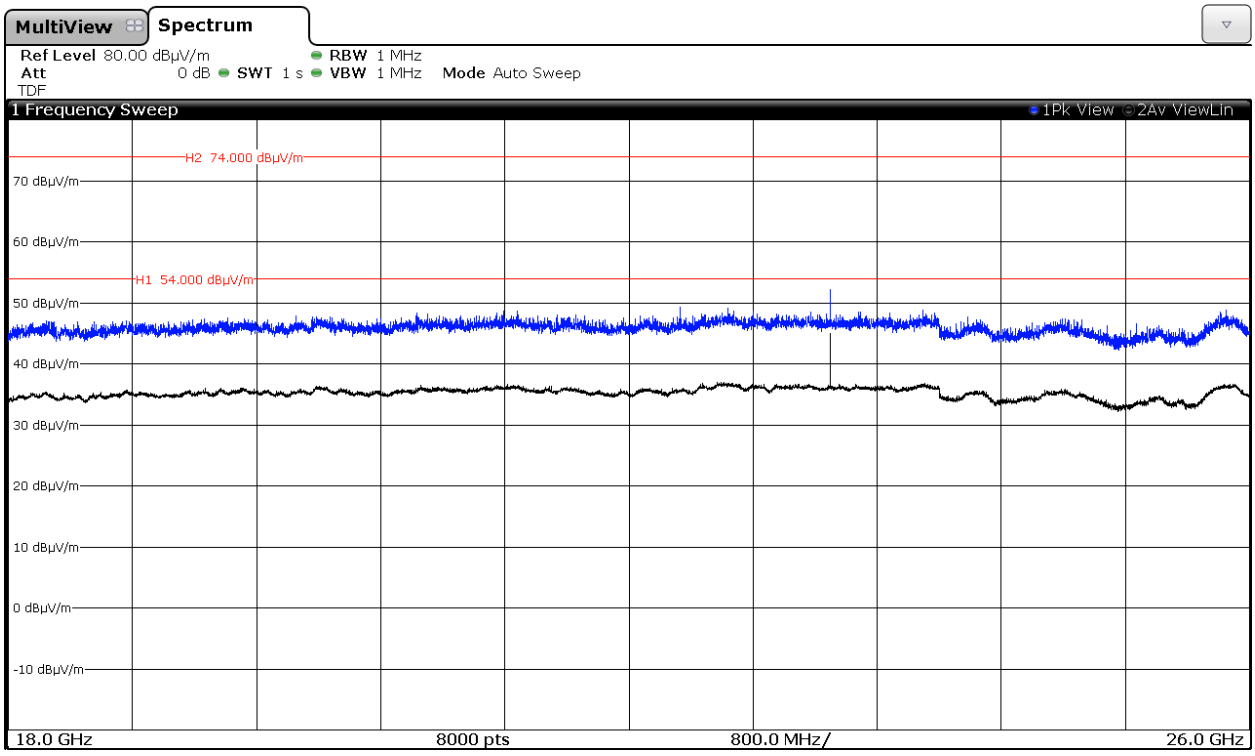
Highest Channel: 5825 MHz. Chain A



Highest Channel: 5825 MHz. Chain B

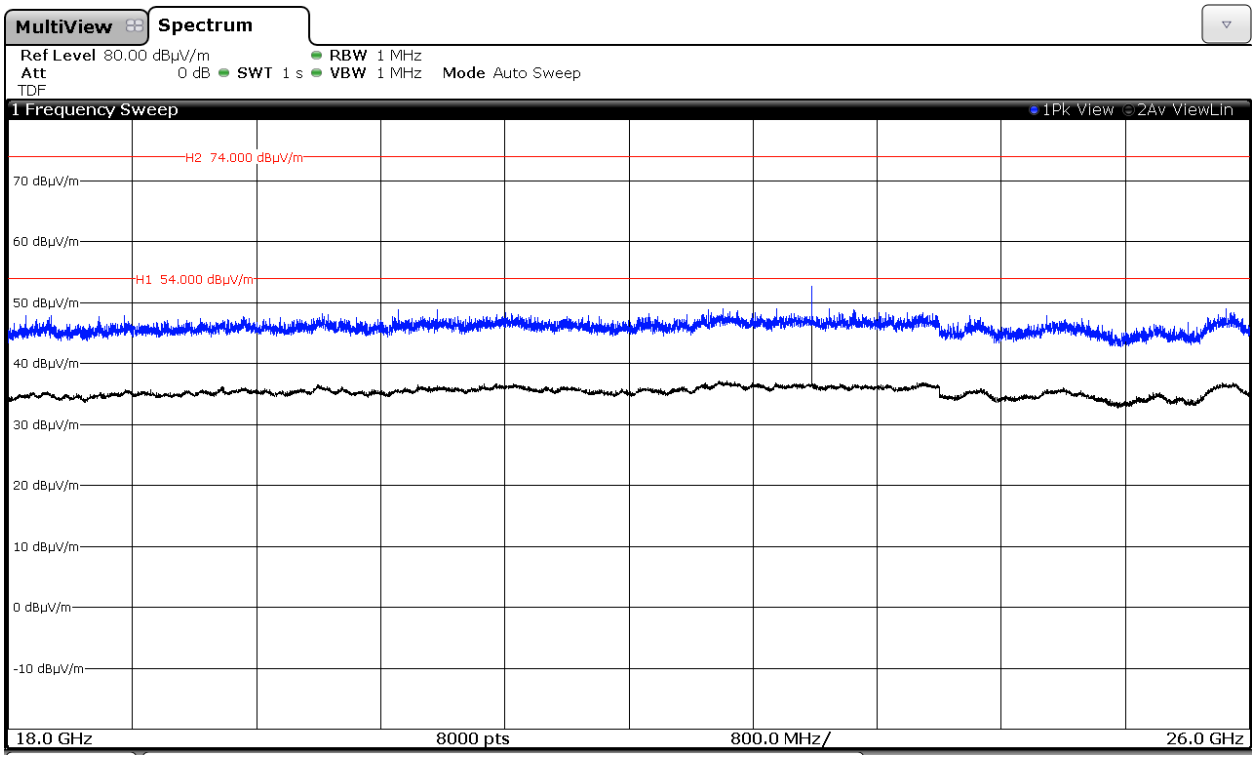


Highest Channel: 5825 MHz. Chain A+B

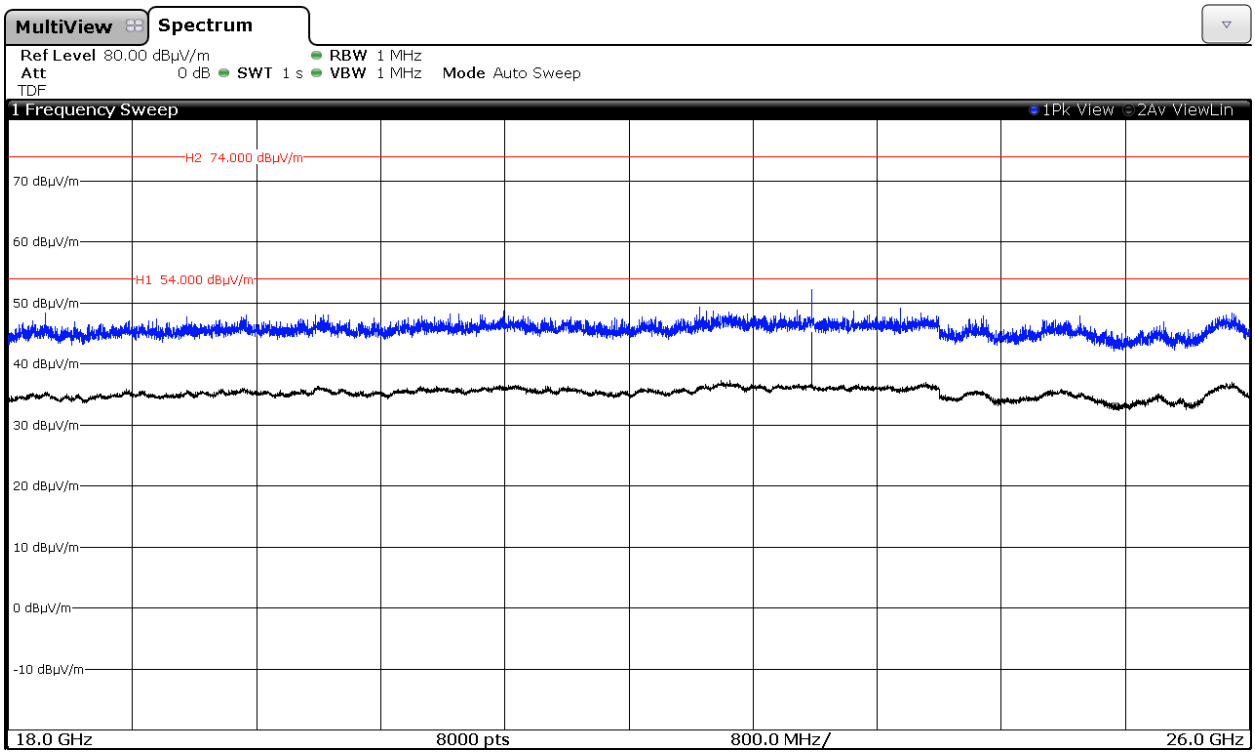


3. WiFi 5GHz 802.11 n40 mode

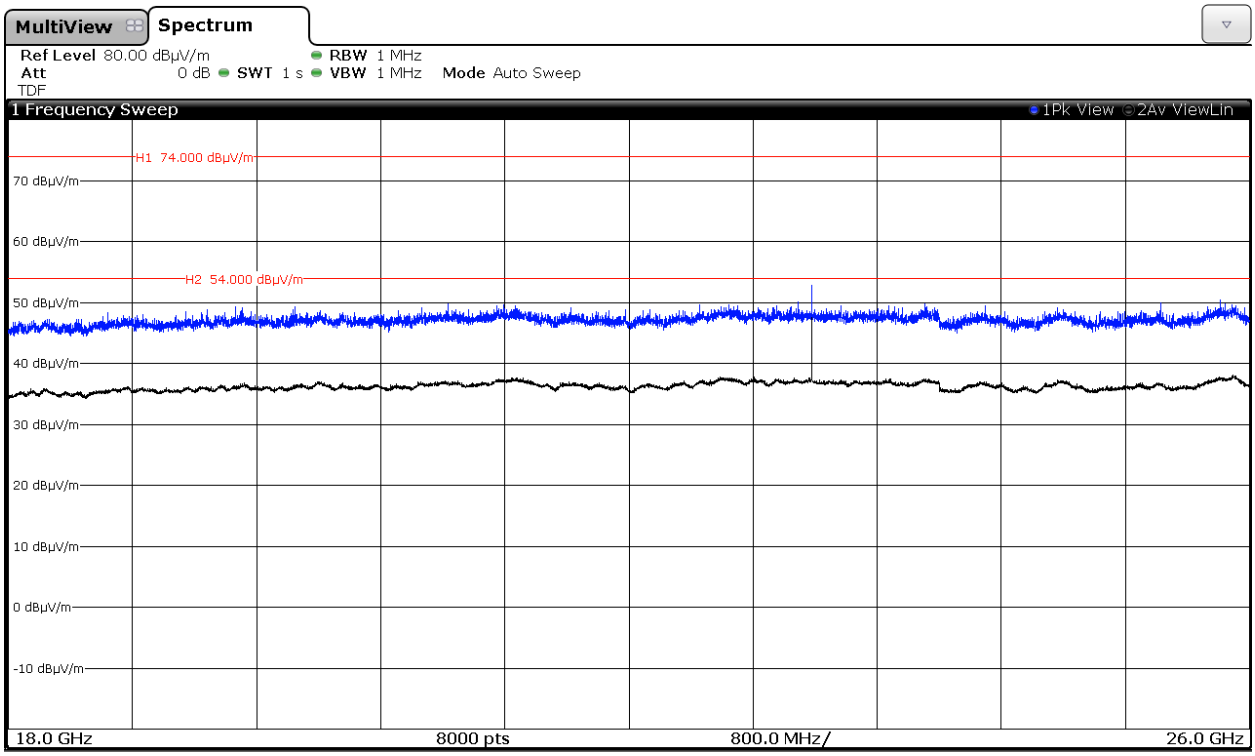
Highest Channel: 5795 MHz. Chain A



Highest Channel: 5795 MHz. Chain B

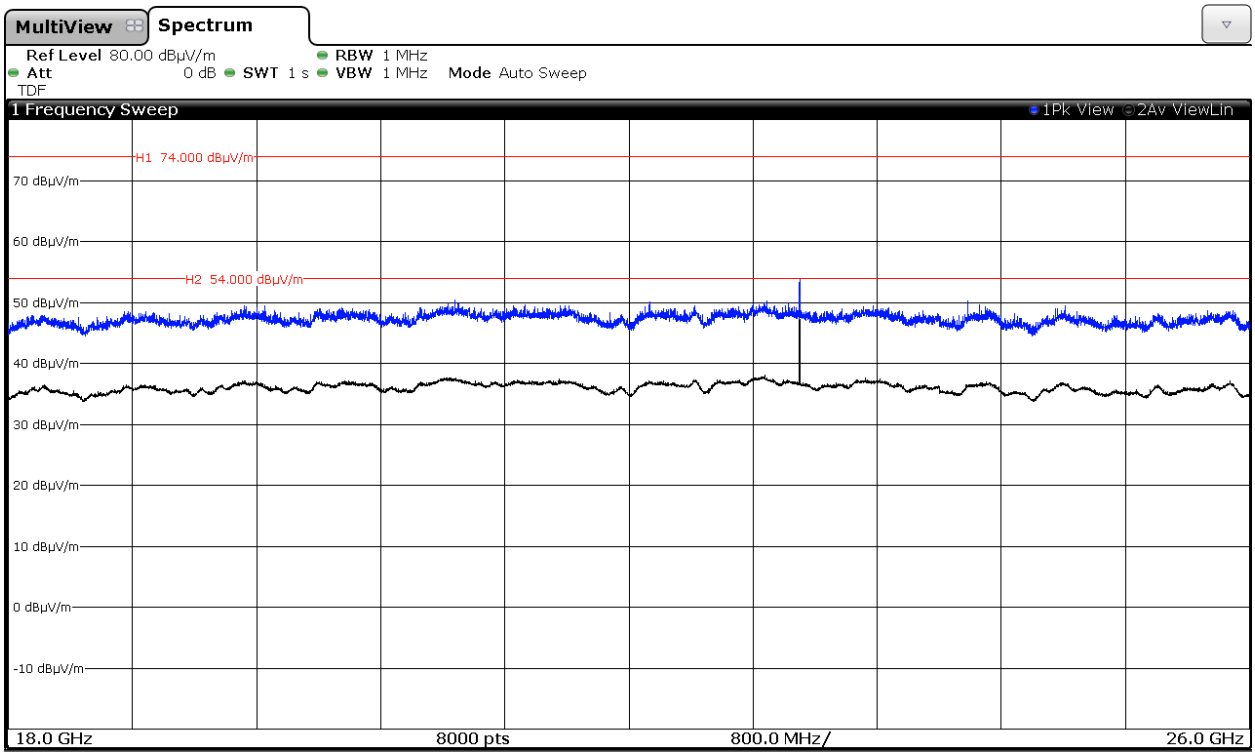


Highest Channel: 5795 MHz. Chain A+B

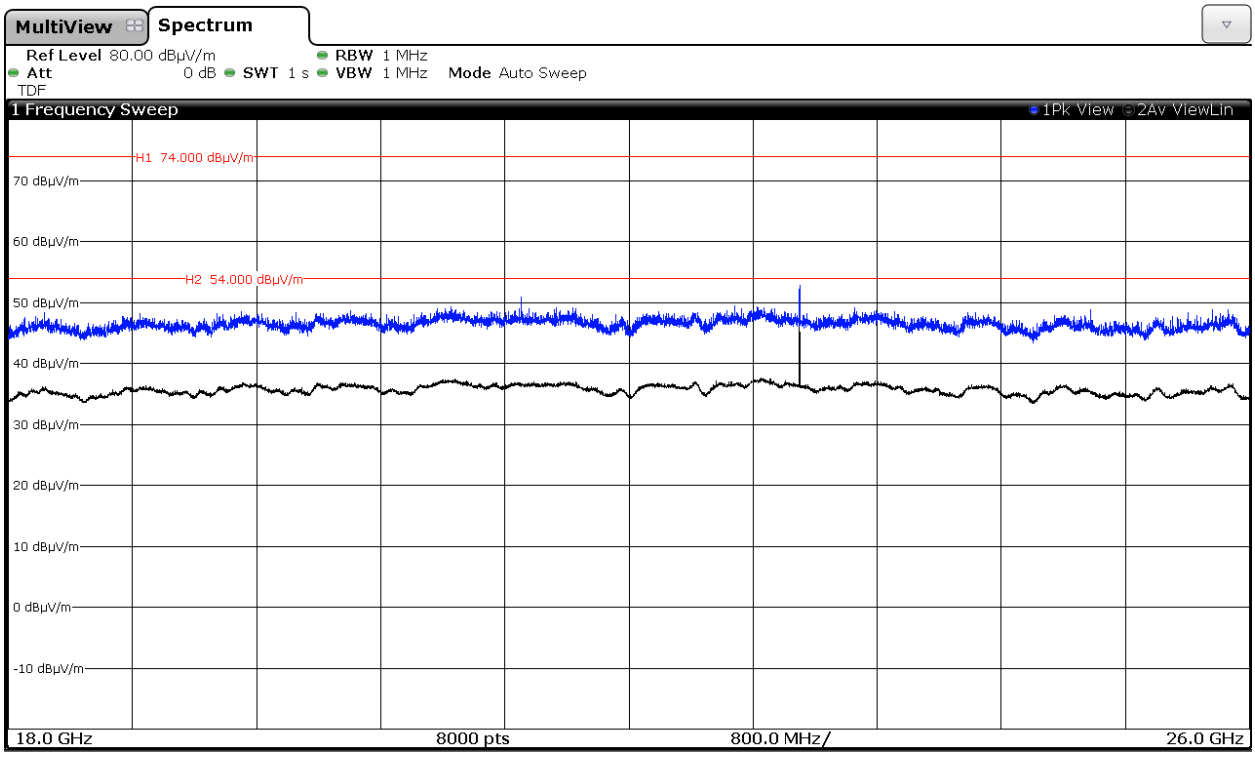


4. WiFi 5GHz 802.11 ac80 mode

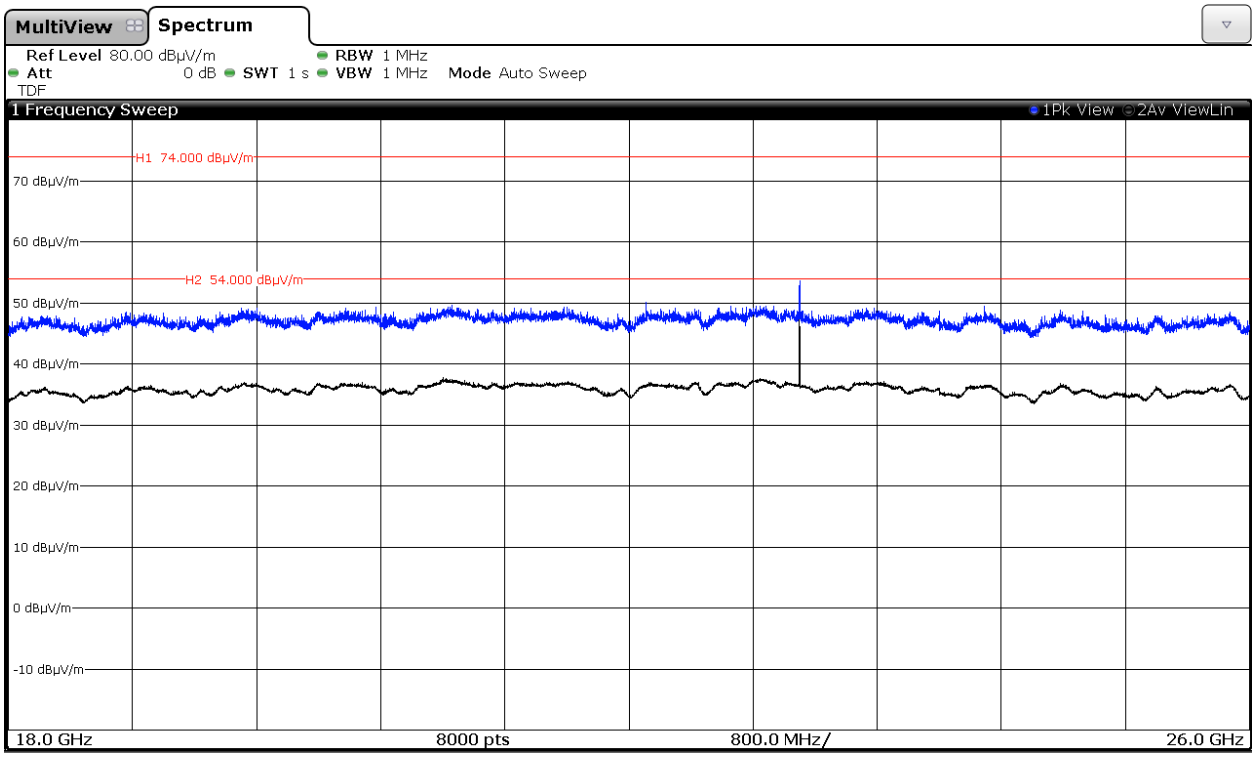
Middle Channel: 5775 MHz. Chain A.



Middle Channel: 5775 MHz. Chain B.

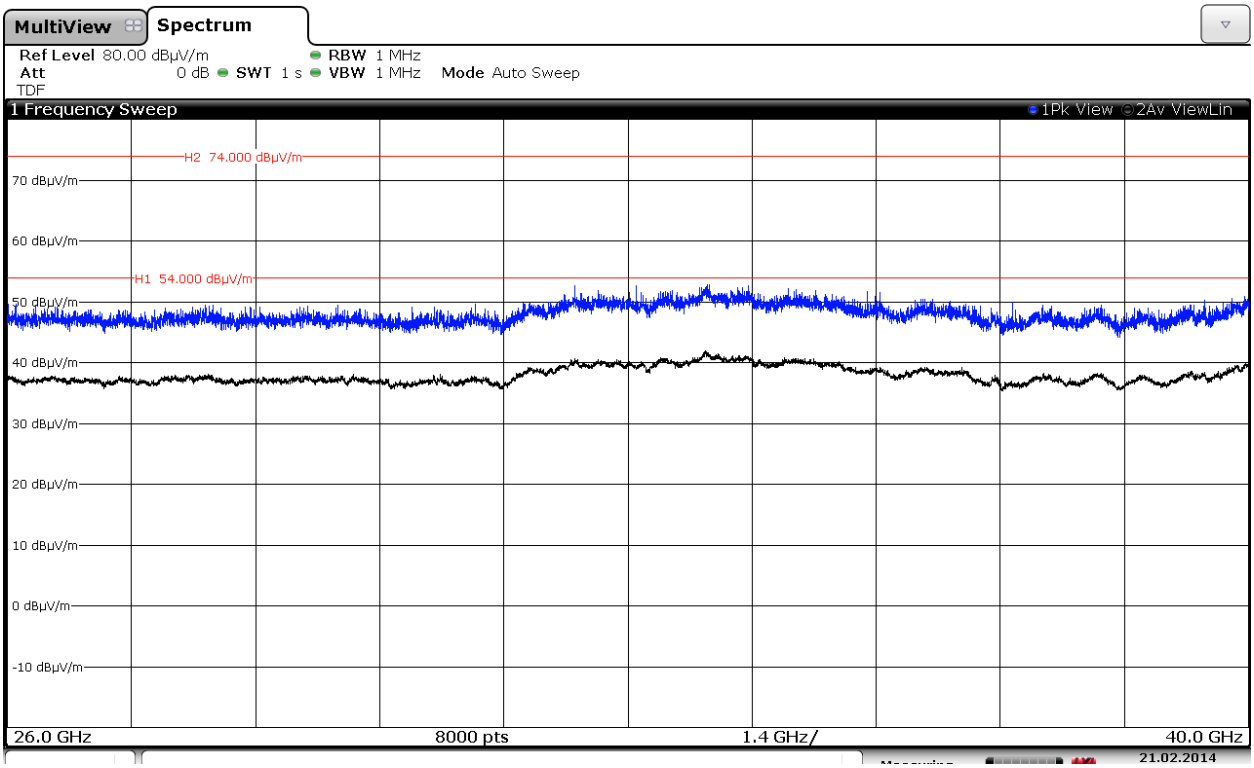


Middle Channel: 5775 MHz. Chain A+B.



FREQUENCY RANGE 26 GHz to 40 GHz.

No spurious signals were found in all modulations and channels tested.



(This plot is valid for both SISO and MIMO modes).